EXHIBIT 7

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

CARNEGIE INSTITUTION OF WASHINGTON, M7D CORPORATION, *Plaintiffs*, v. FENIX DIAMONDS, LLC, *Defendant*.	Civil Action No. 1:20-cv-00200-JSR

EXPERT REPORT OF KAREN K. GLEASON, PH.D.
REGARDING VALIDITY OF
U.S. PATENT NOS. 6,858,078 AND RE41,189

Exhibit	Description
83.	U.S. Patent No. 5,326,171 to Thompson et al., titled "Pyrometer Apparatus and Method," issued July 5, 1994 ("Thompson")
84.	U.S. Patent No. 5,308,161 to Stein, titled "Pyrometer Apparatus for Use in Rapid Thermal Processing of Semiconductor Wafers," issued May 3, 1994 ("Stein")
85.	U.S. Patent No. 5,549,756 to Sorensen et al., titled "Optical Pyrometer for a Thin Film Deposition," issued August 27, 1996 ("Sorensen")
86.	Britannica.com at https://www.britannica.com/science/angle-of-incidence
87.	M. Ignatiev et al., "Two-dimensional resolution pyrometer for real-time monitoring of temperature image in laser materials processing," Applied Surface Science 109/110, 498-508 (1997) ("Ignatiev")
88.	U.S. Patent No. 5,501,740 to Besen et al., titled "Microwave Plasma Reactor," issued Mar. 26, 1996 ("Besen")
89.	M.R. Wertheimer et al., "Plasmas and polymers: "From laboratory to large scale commercialization," Pure & Appl. Chem., Vol. 68, No. 5, 1047-1053 (1996) ("Wertheimer")

Appendix	Description
Appendix A	Karen K. Gleason CV
Appendix B	Karen K. Gleason of Expert Engagements for the Last Four Years
Appendix C	Materials Considered
Appendix D	Opinion and Order Concerning Claim Construction ("Markman Order"), *Carnegie Institute of Washington v. Pure Grown Diamonds, Inc.* (S.D.N.Y. Case No. 20-CV-189) and Carnegie Institute of Washington v. Fenix Diamonds, LLC (S.D.N.Y. Case No. 20-CV-200), May 8, 2020

II. INTRODUCTION

1. This validity expert report regarding U.S. Patent No. 6,858,078 ("the '078 Patent") and U.S. Patent No. RE 41,189 ("the '189 Patent") is respectfully submitted in connection with

the case captioned Carnegie Institute of Washington v. Fenix Diamonds LLC. (S.D.N.Y. Case No. 20-CV-200).

2. I have been retained in this matter by plaintiffs Carnegie Institute of Washington and M7D Corporation ("Plaintiffs") to opine regarding validity issues in this case, including the validity of the '078 Patent titled "Apparatus and Method of Diamond Production" attached as Exhibit 1 and the '189 Patent titled "Method of Making Enhanced CVD Diamond" attached as Exhibit 2.

3. I understand that Plaintiffs contend that certain claims are infringed by Defendant as shown in the table below. Collectively I refer to these as the "Asserted Claims."

Asserted Patent	Asserted Claims (Infringement)
The '078 Patent	**1,** 6, 11**, 12**, 16
The '189 Patent	1, 2

4. This report is submitted in response to the September 18, 2020 Opening Expert Report of J. Michael Pinneo, Ph.D. regarding invalidity of the '078 Patent and '189 Patent.

5. I reserve the right to modify or supplement my opinions, as well as the basis for my opinions, based on the nature and content of the documentation, data, proof and other evidence or testimony that Defendant or their experts may present or based on any additional discovery or other information provided to me or found by me in this matter.

6. I anticipate using as exhibits during trial certain documents and things referenced or cited in this report or accompanying this report. I also anticipate using other demonstrative exhibits at trial.

significant degradation, and heating to above 1600℃ "totally destroyed sample integrity due to the formation of cracks." *Id*. 2:26 – 32.

87. The '189 Patent describes a new way of applying certain temperatures and pressures to a CVD single-crystal diamond or diamond film that improves rather than diminishes its properties. The patent teaches to encapsulate the CVD diamond in an outer body, preferably of graphite, which can be fitted into a high-pressure, high-temperature apparatus. *Id*. 2:51–67, Fig. 1. Applying higher atmospheric pressure and higher temperatures typically associated with graphite stability results not in degraded diamonds or graphite, but instead a more perfect diamond crystalline material. *Id*. 2:29–50. This quick, repeatable process improves the optical, electrical, thermal, and mechanical properties of CVD diamonds, making them more valuable. *Id*. 1:10–12, 1:43–45, 1:61–65, 1:67–2:3, 2:29–34. Notably, the process "causes the optical properties to change so much that opaque material becomes clear." *Id*. 2:31–32; *see also id*. 4:6–8 ("The opaque CVD diamond layer turned clear").

G. Prosecution History of the '189 Patent

88. The reissue application resulting in the '189 Patent was originally filed on January 30, 2009. The reissue declaration filed with the application was signed by Gary Kowalczyk, the Director of Administration and Finance for Carnegie and sought a reissue of the '610 Patent. *See* '189 Patent FH at 7-9 (Reissue Application Declaration by the Assignee, submitted to the patent office on January 30, 2009). The declaration named Wei Li, Russell J. Hemley, Ho-kwang Mao, and Chih-shiue Yan as inventors, and Carnegie's Director explained that "I believe said inventor(s) to be the original and first inventor(s) of the subject matter which is described and claimed in said patent, for which a reissue patent is sought" and that "Robert H. Frushour is

entire redesign of the microwave resonance in the chamber. In addition, the upper chamber may need be designed to hold the reactive gas at a pressure of 500 atm (col 3: 36-37), as opposed to the sub-atm vacuum chamber system of the '078 Patent. Additionally, gas flow balance would need to be redesigned to cause venting from the new lower pressure side of the chamber, in other words, the equipment in the primary references would have to be made to appear more like that in Matsumoto. The alternative is to simply employ the systems of Matsumoto.

345. Regardless of whether the primary reference equipment is redesigned, or Matsumoto's equipment is utilized the system and method described by Matsumoto is not understood to produce single-crystal diamond growth as the nucleated diamond formed in the precipitation zone is randomly oriented. This was discussed above, and I incorporate my prior discussion here by reference. In order to achieve single crystal diamond growth a mechanism for biasing the orientation of the diamond formed in the precipitation zone would have to be employed, and neither Matsumoto nor any of the primary references teach such a mechanism.

346. In view of the foregoing, a POSITA would not have a reasonable expectation of success in to combine Matsumoto with any of the primary references to prepare single-crystal diamond based as set forth in the asserted claims. In addition, the lack of any reasonable expectation of success in combining the references further undermines any motivation to combine the references.

X. PRIOR ART VALIDITY ANALYSIS OF THE '189 PATENT

347. As explained below, it is my opinion that Claims 1 and 2 are not rendered invalid by any of the prior art references or combinations cited by Dr. Pinneo. For reference, I include the language of the claims of the '189 patent below.

U.S. Pat. No. '189

1	A method to improve the optical clarity of CVD diamond where the CVD diamond is single crystal CVD diamond, by raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase.
2	The method of claim 1 wherein the CVD diamond is a single crystal coating upon another material.

348. I understand from counsel that a prior art reference can anticipate a patent claim only if the reference disclosed each element of the claimed invention. In addition, I understand from counsel that anticipation requires not only the identification of the elements of an invention, but they must also be arranged as required by the claim.

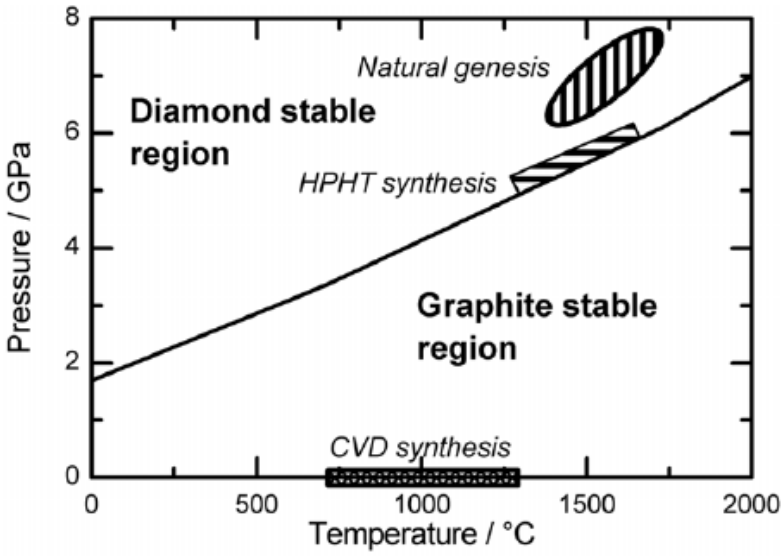
349. I further understand that, for a combination of prior art references to render a patent claim obvious, a person of ordinary skill in the art must have had (1) a motivation to combine the prior art references and (2) a reasonable expectation of success in achieving the claimed invention.

350. As an initial matter, I disagree with statement Dr. Pinneo made when reviewing the Patent Office's Reasons for Allowance for the '189 patent. He claims that, in 2002, the "art included the knowledge that diamond, created by whatever means, exhibited the same properties independent of its origin." Pinneo R. at ¶1317. Dr. Pinneo concludes that "[o]ne of skill in the art would undoubtedly have thought of, and been motived to apple annealing treatments used with natural and/or HPHT diamond to single-crystal CVD diamonds." *Id*.; *see also id*. ¶ 1327.

351. While natural, HPHT, and CVD diamond may have certain properties that are comparable and both be discolored, and clear CVD diamond is desirable for several applications, it is not true in my opinion that skilled artisans would necessarily have been motivated to apply natural- or HPHT-diamond annealing conditions to discolored CVD single-crystal diamond. In 2002, there were many known differences between natural, HPHT, and CVD single-crystal diamond including, most importantly, ones related to the cause of brown color. Those differences

would have prevented any motivation to apply processes for natural and HPHT diamond to CVD diamond, and they not doubt would have prevented any reasonable expectation of success in achieving similar results.

352. The starting reactants, reaction conditions, and duration of the formation period are quite distinct for HPHT, CVD, and natural diamond synthesis, a shown schematically in the reproduced figure from *Balmer*.



Phase Diagram for Carbon Indicating Main Regions of Pressure–Temperature Space in which Diamond Growth Occurs. *Balmer* Figure 2.

Each synthesis method results in a different prevalence of defect types. Since diamonds formed in different ways have very different thermal histories, moreover, a person of skill in the art would anticipate each type would respond differently to subsequent annealing.

353. The impurity present at the highest concentration level in HPHT synthetic diamonds is typically nitrogen. *Collins* at 114-117. Small HPHT diamonds grown at modest temperature (1400 °C) frequently contain ~200 ppm nitrogen, present as isolated substitutional defects. At higher temperatures (1700 to 2100 °C), the nitrogen forms nearest neighbor

substitutional pairs, called A aggregates. At even higher temperature, ~2400°C, B aggregates form, in which four nitrogen atoms surround a vacancy.

354. Nitrogen is also the major impurity typically found in natural diamonds. *Collins* at 114-118. The A and B aggregates in natural diamond form over geological times spans in the earth's mantle at the lower temperatures (~1000 to 1300 °C). *Anthony* [0004]. Diamonds with nitrogen aggregates are classified as Type Ia. The vast majority (> 98%) of large clear diamond are Type Ia. *Anthony* [0003]. Approximately 0.8% of natural stones have nitrogen present as primarily as isolated substitutional defects and are classified as Type Ib. *Anthony* [0003]. In a very small fraction of natural diamonds, the nitrogen impurity levels are below the detection of limit of infrared spectroscopy and these diamonds are classified as Type IIa. *Collins* at 117.

355. Annealing can cause a carbon to migrate away from a lattice site, producing a vacancy and an interstitial carbon atom. *Collins* at 121. The vacancies in diamond continue to migrate during annealing. *Davies 1992* at 13157. In nitrogen-containing diamond, a variety of complexes can form between the nitrogen and the vacancies. *Davies 1992* at 13157-13170; *Collins* at 113-122.

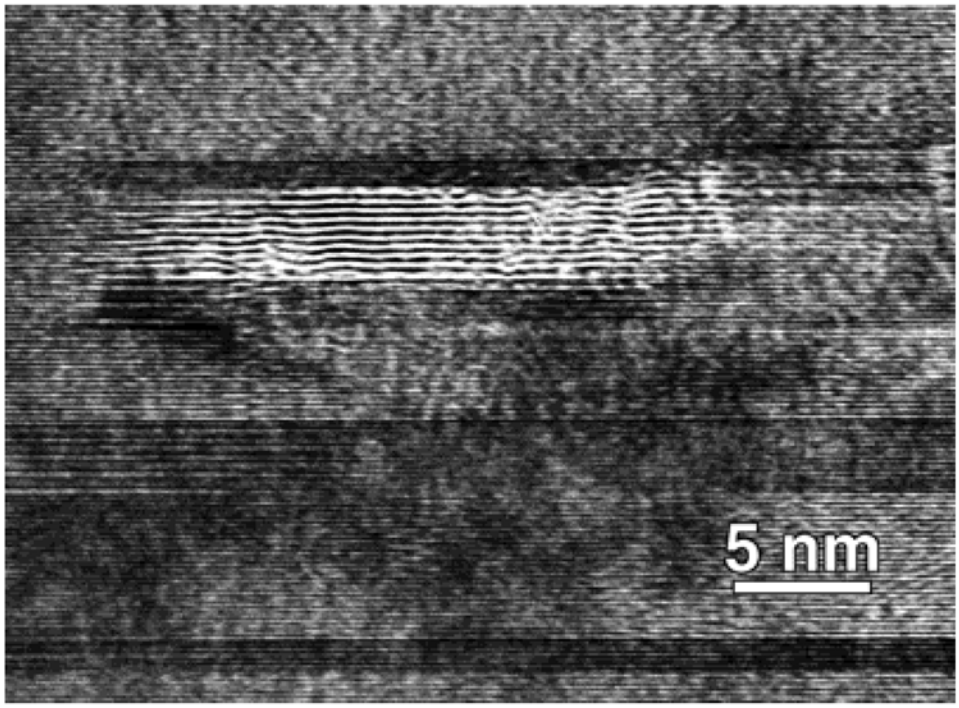
356. In 2000, the optical defect levels in natural brown diamonds were characterized before and after annealing. *Collins* at 113-122. This study had a practical motivation, since the majority of natural diamonds have a brown color which is less desirable for gems. The annealing was carried out either between 1700-1800°C or at 2025°C in a high pressure (6 GPa) press. *Collins* at 114. The nitrogen concentration in the diamonds was as high as 500 ppm.

357. The reduction of brown color in Type Ia diamonds by annealing was determined to correlate with vacancies trapped by nitrogen to form N-V-N defects. *Collins* at 114-118. As compared to Type IIa diamond which are free of nitrogen, Type Ia diamonds have a 40% increase

in vacancy production because the rate of vacancy production and capture is altered in the region close to the nitrogen impurity. *Davies 1992* at 13169.

358. Thus, prior to 2001, detailed and extensive research established that nitrogen impurities impact the fundamental solid-state chemical reactions and kinetics for the annealing of diamond. *Davies 1992* at 13157-13170; *Collins* at 113-122. Hence a person of skill in the art would not expect that the annealing conditions described for improving the color of Type Ia and Ib nitrogen-containing diamonds would produce similar results in the low-nitrogen or nitrogen-free diamond produced by MPCVD.

359. A paper published in 2001 found that vacuum (10^{-5} torr) annealing for 1 hour at temperatures in the range of 1350-1450 °C can produce regions of non-diamond carbon internal to the crystallites of MPCVD diamond. *Nistor* at 207-214. High resolution electron micrographs (HREM), such as Figure 3, displays an intracrystalline region of graphitic sheets, where there is a correspondence of two (0002) graphitic sheets with three (111) diamond planes. This island of graphite extends ~20 nm in the a-direction and ~3 nm in the perpendicular c-direction.



HREM of graphitic sheets internal to an MPCVD diamond crystallite. *Nistor* at 207-214.

360. For type IIa diamond, a HPHT synthesis method and corresponding annealing conditions were taught by *Sumiya*. Type IIa synthetic diamonds, of at least 0.1 carat in size, were grown by the temperature gradient method starting from a defect-free diamond single crystal *Sumiya* at Abstract, Fig. 3, 4:51-67. The resulting HPHT synthesized crystals were colorless and transparent and had fewer than $3x10^5$ etch pits/cm2. *Sumiya* at Abstract.

361. The difference in nitrogen incorporation and lattice perfection for different types of natural and HPHT synthetic diamonds are summarized in Figure 2 (*Sumiya* 3:41-50). The FWHM of the rocking curve valued are from the (004) crystal plane and were obtained using x-ray diffraction.

Diamond	Quantity of Nitrogen (ppm)	FWHM of Rocking Curve (arcsec)
Natural type Ia Diamond	~1000	7–60
Natural type IIa Diamond	<1	200–2500
Synthetic type Ib Diamond	10–120	6–20
Synthetic type IIa Diamond	<0.1	4–6

FWHM of Rocking Curve of Various Diamonds. *Sumiya* 3:41-50

362. *Sumiya* taught that annealing at high pressure (≥ 7 GPa) and high temperature (≥ 1000 ° C) results in the mechanical deformation of the diamond and results in the removal of carbon atoms from the diamond lattice. *Sumiya* 3:9-13. Furthermore, high pressure annealing requires an expensive apparatus and new defects can be incorporated into the diamond as the pressure and temperature are lowered back to atmospheric values at the end of the annealing step. *Sumiya* 3:14:18. While type IIa diamond have low impurity levels, they suffer from lattice defects that lead to strain and sometime break when compressed. *Sumiya*, 3:20-32. Thus, to avoid deformation, loss of carbon, the potential incorporation of new defects, and breaking of type IIa stones, a person of skill in the art would seek to avoid annealing at high pressures and high temperatures.

363. *Sumiya* taught the heat treatment conditions for HPHT synthesized Type IIa diamonds. *Sumiya* 6:23-67; 7:1-7. The recommended annealing conditions combined low pressure, a high temperature (LPHT) between 1100 °C and 1600 °C, and a non-oxidizing atmosphere, and the figure below gives examples of specific conditions. Sumiya 12:53-67. Thirteen of examples in the figure below used a pressure of 120 torr, which is less than atmospheric pressure (760 torr) and equal to 1.6 x 10^{-5} GPa. The remaining example was at <10^{-3} torr. Thus, for heat treating Type IIa MPCVD diamonds, a person of skill in the art would have been motivated to utilize a combination

of conditions taught by *Sumiya*. For example, in a 2009 publication LPHT annealing of MPCVD diamond is reported. *See Liang 2009* at Abstract. Rather than LPHT annealing, the combination of conditions of the '189 Patent represent HPHT annealing. In the'189 Patent, high pressures (> 4.0 GPa) are combined with high temperature (> 1500 °C). '189 Patent 3:1-3. Note that the lowest pressure recommended by 'the '189 Patent (4 GPa) is 250,000x the 120 torr values reported in the figure below.

			Heat Treatment Conditions				
Sample No.	Kind of Diamond	Impurity	Heating Method	Temperature	Atmosphere	Total Pressure	Oxygen Partial Pressure
Example							
1	Art. IIa	no	Micro.	1100° C.	H_2	120 Torr	$<10^{-3}$ Torr
2	Art. IIa	no	Micro.	1200° C.	H_2	120 Torr	$<10^{-3}$ Torr
3	Art. IIa	no	Micro.	1600° C.	H_2	120 Torr	$<10^{-3}$ Torr
4	Art. Ib	no	Micro.	1200° C.	H_2	120 Torr	$<10^{-3}$ Torr
5	Art. Ib	no	Micro.	1500° C.	H_2	120 Torr	$<10^{-3}$ Torr
6	Art. IIb	no	Micro.	1200° C.	H_2	120 Torr	$<10^{-3}$ Torr
7	Natu. Ia	no	Micro.	1150° C.	H_2	120 Torr	$<10^{-3}$ Torr
8	Natu. Ia	no	Micro.	1150° C.	H_2	120 Torr	$<10^{-3}$ Torr
9	Art. IIa	no	Micro.	1100° C.	H_2	120 Torr	$<10^{-3}$ Torr
10	Art. IIa	no	Micro.	1300° C.	H_2	120 Torr	1 Torr
11	Art. IIa	no	Micro.	1100° C.	H_2	120 Torr	$<10^{-3}$ Torr
12	Art. IIa	no	Micro.	1200° C.	Ar	120 Torr	$<10^{-3}$ Torr
13	Art. IIa	no	Resist.	1200° C.	Air	$<10^{-3}$ Torr	$<10^{-3}$ Torr
14	Art. IIa	no	HF	1200° C.	N_2	120 Torr	5 Torr
Comparative Example							
1	Art. IIa	no	Micro.	1000° C.	H_2	120 Torr	$<10^{-3}$ Torr
2	Art. IIa	no	Micro.	1650° C.	H_2	120 Torr	$<10^{-3}$ Torr
3	Art. IIa	no	Micro.	1200° C.	H_2	120 Torr	50 Torr
4	Art. IIa	no	Resist.	1200° C.	Air	250 Torr	50 Torr
5	Art. IIa	yes	Micro.	1200° C.	H_2	120 Torr	$<10^{-3}$ Torr
6	Art. IIa	no	Micro.	1200° C.	H_2	120 Torr	$<10^{-3}$ Torr

(Note)
Art. IIa: artificial type IIa diamond
Natu. Ia: natural type Ia diamond
Micro.: microwave heating
Resist.: resistance heating
HF: high frequency induction heating

Annealing Conditions Presented in *Sumiya*. *Sumiya* 3:41-50

364. In this figure, the abbreviation "Art." is shorthand for "artificial" and indicates synthetic diamond grown by the HPHT thermal gradient process.

365. Additionally, a person of skill in the art would be aware that annealing at high temperature (1200 °C) and high pressure (2 GPa = 1.5x107 torr), which falls in the stability region for graphite, causes crystalline graphite crystals to grow on the surfaces of HPHT synthesized diamond. *See Qian* at 1632-1637.

366. By 2000, the ability to grow MPCVD diamonds with low levels of nitrogen impurities had been established. *Nistor* at 8741-8745. Utilizing high flow rates of H2 gas into the MPCVD chamber correlated with a reduction in both nitrogen and hydrogen impurities in the diamond film. The highest flow rate of H2 gas corresponded with 1.5 ppm of nitrogen and 140 ppm of hydrogen as impurities in the polycrystalline film. *Nistor* at 8742.

367. The presence of nitrogen in the plasma was known to increase twinning and stacking faults (*Nistor* at 8745) and thus a person of skill in the art would seek to reduce nitrogen incorporation in single crystal MPCVD diamond. The person of skill in the art would also be motivated to reduce nitrogen incorporation during growth to improve the color and value of the as-grown diamond. Based on the teachings of *Nistor* (at 8741-8745) for reducing nitrogen incorporation during the growth of polycrystalline diamond, a person of skill in the art would reasonably expect that the same growth methods would also likely reduce nitrogen incorporation in single crystal MPCVD diamonds. Additionally, the person of skill in the art might expect that, because of the higher order in the single crystal, nitrogen incorporation would likely be less than the 1.5 ppm observed for the polycrystalline film. That value would be less than the concentrations known for natural Type IIa diamond. *Sumiya* 3:41-50. A person of skill in the art would expect the level of incorporated nitrogen to impact the post-growth annealing processes.

368. High-resolution electron-energy-loss spectroscopy (HREELS) identified the hydrogen bonding configurations surface of thin epitaxial layers of MPCVD diamond. *Aizawa* at 18348-18350. Only sp^3-hybrizied bonding was detected, consistent with diamond being present without graphitic carbon. The (111) surface retained the same periodicity as the underlying diamond lattice as was terminated by methyl ($-CH_3$) groups. The (100) surface, which of the most interest of MPCVD epitaxy, was terminated by monohydride (-CH) groups. The carbon atoms in the topmost layer of the (100) surface displayed a (2x1) reconstruction with respect to the underlying diamond lattice. The high concentrations of atomic hydrogen present in the microwave plasma are the source of the hydrogenated surfaces in MPCVD diamond. In contrast, neither natural diamond or HPHT diamond rely on hydrogen as a reactant for the growth. Thus, the possibility of incorporated hydrogen to interact with mobile vacancies during annealing is a distinguishing characteristic of MPCVD diamond. The unique characteristic of hydrogen incorporation may contribute to differences in the annealing kinetics of MPCVD diamond as compared to natural or HPHT synthetic diamond. Indeed, the presence of hydrogenated surface may contribute to the ability of HPHT annealing performed under the graphite-stable region of bulk carbon to improve lattice perfection of MPCVD diamond.

369. Accordingly, i 2001, the cause of brown color in natural single-crystal diamond was unclear. *Kolodzie*. As explained above, *Nistor* found graphitic defects inside CVD diamond crystals. I am unaware that anyone had found such defects inside HPHT or natural diamond crystals before the priority date. The graphitic defects inside the CVD diamond extended over multiple lattice sites as opposed to the point defects or stacking/dislocation defects in the diamond sp^3 carbon lattice. The unknown cause of brown discoloration persisted well past the priority date. Scientific literature from 2009 explains that "the origin of the [brown] colour and the microscopic

mechanisms behind its removal have remained unclear," *Maki* at 1. Authors of a 2013 paper had "not been able to completely elucidate the nature of the defect responsible for brown colour" "in CVD diamond." *Kahn* at 10.

370. The types of defects in CVD diamond were believed to be different than the defects identified natural and HPHT diamond. Both annealing behavior and color centers are driven by the imperfections in diamond and these imperfections depend on whether the diamond formed naturally, was synthesized by an HPHT process, or was grown by CVD. Thus, skilled artisans would not have been motivated to apply the same annealing conditions to these varying types of diamond, and they would not have had a reasonable expectation of success in annealing CVD diamond with conditions used on natural or HPHT diamond. Dr. Pinneo oversimplifies the issue with his rudimentary argument that, simply because natural, HPHT, and CVD diamond may be similar in certain regards, skilled artisans would have been motivated to apply natural and HPHT diamond annealing conditions to CVD diamond despite known differences that would affect annealing processes.

371. Additionally, *Bangert* states the origin of the brown color in diamonds remained controversial even in 2006 and that the source of the brown color in natural and CVD diamonds was likely different:

> The origin of the brown colour in type IIa natural and CVD diamond has been an issue of dispute for several years. Brown diamonds can be transformed into the colourless variety by High-Pressure High-Temperature (HPHT) treatment. To be able to tell whether such treatment has been applied, and, on a more fundamental level, to elucidate the origin of the colouration and the mechanism for its loss is of considerable interest to gemmologists and gem traders. Other colourations, e.g. yellow, blue, red and grey can be attributed to trace elements. However, brown type IIa diamond has few impurities and the brown colouration is largely due to native defects.
>
> It is believed that all brown natural diamonds have undergone plastic deformation at some stage in their past (although not all plastically

> deformed diamonds are brown), and since plastic deformation results in dislocations and there are high numbers of these in brown diamond, the question arises, in the light of lack of impurities, whether the colour is due to electronic states at dislocations. However, it is recognized that brown CVD diamonds can have very few dislocations: of density 10^5 cm^2 compared with 10^9 cm^{-2} in natural type IIa brown diamonds, and this implies that dislocations are not the sole source of brown colouration.

Bangert at 4766.

372. Graphitic inclusion internal to MPCVD diamond crystals have been identified by electron microscopy. *See Nistor* at 207-214. Such inclusions of sp2 carbon would likely decrease the optically clarity of the diamond. It would be surprising to a person of skill in the art if graphitic inclusions in diamond annealed out at the same temperatures, pressures, duration, and environment (i.e. vacuum, inert gas) as other very different types of defects which include, but are not limited to, dislocations, vacancies, and nitrogen impurities.

373. Many clear plastics yellow with age. The aging reactions produce sp2 carbon. At high enough levels of aging, the plastic can appear brown. The inclusion of sp2 carbon has not been ruled out as a source of the yellow and brown color in MPCVD diamond.

Exemplary aging of Plastic. https://www.polymersolutions.com/blog/wp-content/uploads/accelerated-uv-testing-can-be-used-to-identify-points-of-failure-in-poly_1838_40012042_0_14109937_500.jpg

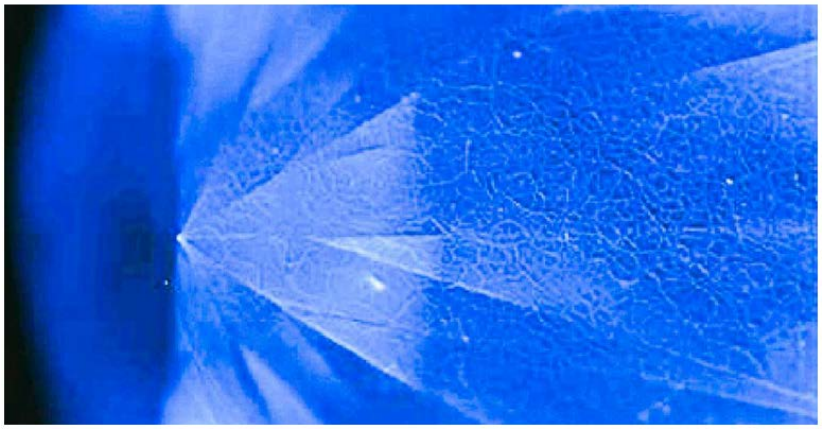
374. Skilled artisans would have lacked motivation and reasonable expectations of success for several other reasons also. One means to reduce nitrogen impurities in CVD diamond, high flow rates of hydrogen gas are used in MPCVD chambers, leading to hydrogen concentrations of 140 ppm in polycrystalline CVD diamond. *Nistor* at 8742. A 1993 study identified hydrogen bonding configurations of thin epitaxial MPCVD diamond, detecting sp^3-hybridized bonding only *Aizawa 1993*, pg. 18348-18350. While the (111) surface retained the same periodicity as the underlying diamond lattice and was terminated by methyl ($-CH_3$) groups, the (100) surface was terminated by monohydride (-CH) groups. The topmost layer of the (100) surface displayed a (2x1) reconstruction with respect to the underlying lattice. The hydrogenated surfaces of MPCVD diamond are caused by the high concentrations of hydrogen present in MPCVD chambers.

375. In 1999, the inventors also documented a defect that was unique to single crystal CVD diamond. Using electron paramagnetic resonance ("EPR"), *Yan 1999* reported defects in

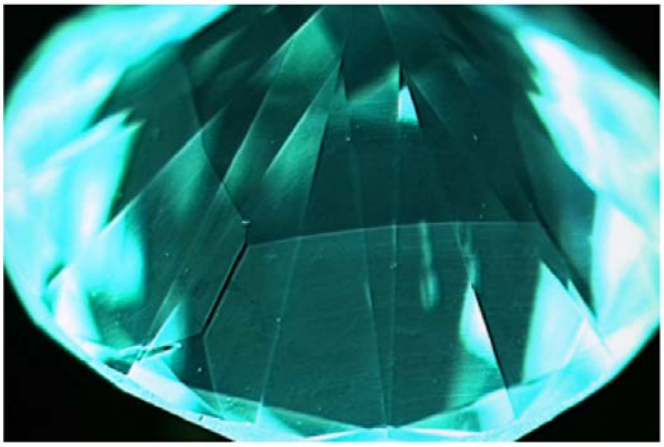
single crystal homoepitaxial MPCVD diamond associated with singly substituted nitrogen impurities (P1-centers), as are also observed in natural diamond. The EPR spectra in *Yan 1999* also contained an isotropic defect at g=2.0033 which could not be assigned by correspondence to EPR studies on natural or HPHT diamond. Thus, a person of skill in the art would be aware that the EPR could identify defects found in MPCVD single-crystal diamond that had not previously been identified in natural or HPHT diamond. An EPR study of single-crystal CVD diamond in 2004 assigned a defect with g~2.0034 and a small degree of anisotropy as a negatively-charge vacancy hydrogen complex, thus confirming and replicating the finding in Yan 1999. Claire Glover et al., "Hydrogen Incorporation in Diamond: The Nitrogen-Vacancy-Hydrogen Complex," 90 Physical Review Letters 185507-1 to -3 (2003). A vacancy-hydrogen complex was also identified as a point defect in single crystal diamond in 2004. Claire Glover et al., "Hydrogen Incorporation in Diamond: The Vacancy-Hydrogen Complex," 92 Physical Review Letters 135502-1.

376. The structural differences between natural, HPHT, and CVD diamond known at the time have been further characterized since 2002. A simple visual depiction of structural differences is shown with the DiamondView instrument, which was introduced in the 1990s. *Breeding at 250*. DiamondView produces surface luminescence images from diamonds that have been bombarded short wavelength (<227 nm) ultraviolet emission from xenon lamps. The DiamondView images below shows web-like dislocation features on natural diamond (top), block-like dislocation features on HPHT diamond (middle), and curved growth lines on CVD diamond (bottom). While defects appear to migrate into layers for CVD diamond, the exact reason is unknown. But the structural pattern makes the orientation of CVD diamond in HPHT

presses more critical than orientation for natural and HPHT diamonds. The defect architecture alsomakes breaks and cracks during annealing processes more likely for CVD diamond.



http://www.iidgr.com/innovations/diamondview/



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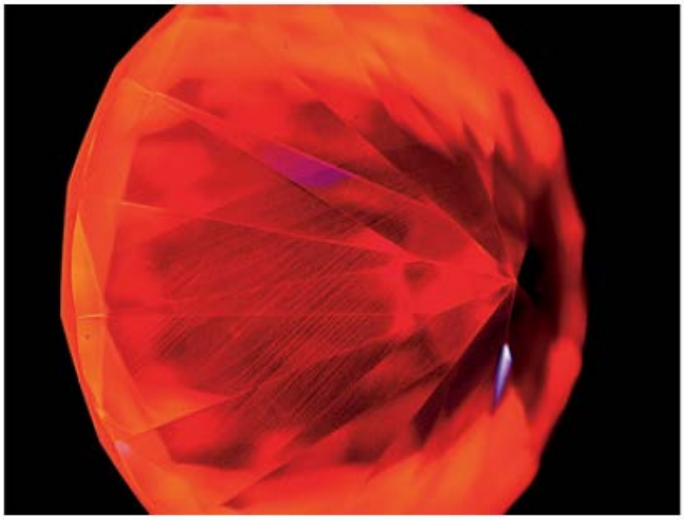


Breeding at 250

377. These structural defects in CVD diamond lead to stress and possible breaks during high-pressure annealing processes. *See Sumiya*, 3:20-32. The additional risk of damage for CVD diamond further exacerbates concerns skilled artisans already had. Damage during the decompression steps of HPHT annealing was already a known issue for other types of diamond, *Sumiya* 3:14:18, and the structural characteristics of CVD diamond made this risk greater. The potential benefit of high-pressure procedures would not have motivated skilled artisans to take this risk because, by definition, Type IIa diamond has low level of impurities, minimizing the potential improvements of annealing procedures. This was compounded by the high cost of equipment needed to reach the high pressures. Accordingly, artisans were more motivated to explore low-pressure annealing methods, not high-pressure procedures, and *Sumiya* did just that that—it disclosed LPHT annealing procedures at vacuum conditions, namely, pressures of 1.6 x 10^{-5} GPa (120 torr). *Sumiya* 12: 53-67. Scientists at Carnegie likewise explored LPHT techniques in addition to the HPHT techniques in their '189 patent. *Liang 2009* abstract. I therefore disagree with Dr. Pinneo's argument that the manufacture method was of no moment. The opposite was true. The CVD-grown nature of the diamond would have been considered and would have led to a low-

pressure processes or prevented a reasonable expectation of success for high-pressure conditions used on natural and HPHT diamond.

378. Testimony from inventor Russell Hemley skilled artisans at the time questioned the applicability of HPHT annealing condition for natural IIa diamond to CVD IIa diamond because of the distinct causes of their brown color. During deposition, Dr. Hemely reviewed a presentation by scientists from the Naval Research Laboratory (Jim Butler) reporting on HPHT annealing studies on single crystal CVD diamond, and Dr. Hemley gave the following testimony about Dr. Butler's observations:

> **Q.** Do you see the first observation titled "HPHT annealing converts 'black' CVD to 'clear'"?
>
> **A.** Yes.
>
> **Q.** Do you see the last bullet point underneath there? It says, "Very similar to annealing of 'brown' natural diamonds."
>
> **A.** Yes.
>
> **Q.** Do you know what that's referring to?
>
> **A.** It is referring to the annealing of diamonds produced in the earth that are brown. And I disagree with that hypothesis.
>
> **Q.** Did you disagree with it at the time?
>
> **A.** I didn't prepare this. I had questions about it then, but this was prepared by Jim Butler.
>
> **Q.** Did you raise your concerns with Mr. Butler at the time or -- excuse me -- Dr. Butler at the time?
>
> **A.** I don't recall. It took us a while to understand or for me to appreciate -- I'm not sure this is widely understood or appreciated, but the brown color of natural diamonds is due to other processes, other phenomena than the brown in CVD diamond.

Hemely Tr. 201:5-202:3

379. Robert Frushour also explained in deposition that CVD diamond discoloration has different causes than natural diamond discoloration, and there was no reasonable expectation of success in applying natural diamond annealing conditions to CVD diamond:

> **Q.** As far as someone that is using HPT -- HPHT annealing processes, someone that has experience using those processes on single crystal natural diamonds and the color changes that result, would they also expect to see similar color changes when applying those processes on a single crystal CVD diamond?
>
> **A.** Would they expect it, you say?
>
> **Q.** Yes.
>
> **A.** Well, everybody is different. I was hoping that that's what would happen, right.
>
> But I wasn't sure with the CVD crystal -- the reason it was dark and not clear might have been a different reason.
>
> With -- we often thought with natural, it was strain related or stress related. But with CVD, it could be due to many other things, the impurities within it or whatever. So you don't know.
>
> Frushour Tr. 70:1-19.
>
> **Q.** I believe you said that at the point in time when you started treating CVD diamonds, you hoped to achieve results like you were for the natural diamonds, but you didn't necessarily expect those results to come through.
>
> . . .
>
> First of all, is that what you said?
>
> **A.** It might have been what I said. It's been a little while ago.
>
> Let's see. When I treated the diamond, I hoped that it would work, but I wasn't sure why the diamond -- I don't know if anybody knows -- why the diamond wasn't clear in the first place.
>
> So it might have been for a reason that high-pressure treatment wouldn't have any impact. You know, if it was due to -- if it was due to some impurities in there, like hydrogen or some sp3 bonding that wouldn't convert to sp4 under high pressure, then it may not convert.

> So thats why you do the experiment. And when you did the experiment and it turned clear, then, of course, I was happy.
>
> **Q.** And these potential impurities that might have kind of prevented you from getting the results, you didn't know whether or not -- well, let me ask the question: Would those have been present in natural diamonds?
>
> **A.** Not necessarily, no. Because the formation of natural diamonds and the formation of CVD diamonds are two entirely different processes.
>
> **Q.** So --
>
> **A.** Not to say that they wouldn't be in there, but I would -- I would think, in my mind -- my opinion is that the impurities could be different in the amounts or the types in natural versus CVD.
>
> **Q.** And so did you have reason to expect or believe that the CVD diamonds would behave differently than the natural diamonds in response to these HPHT treatments?
>
> **A.** I had all kinds of reasons. I could sit there and think of reasons why it might work, and I can come up with reasons why it might not work.
>
> I didn't have any strong expectations to say, well, this is going to happen. I thought anything could happen. You know, you don't know until you run the experiment.

Frushour 117:10-119:19.

A. The Alleged Admitted Prior Art Does Not Anticipate or Render Obvious Claims 1 and 2 of the '189 Patent

380. Dr. Pinneo reviews a passage from the '189 patent's background section that gives temperature and pressure ranges previously used to anneal natural and HPHT type I and type II diamond. Pinneo R. at ¶ 1329 (quoting '189 patent 1:34-42). He claims these conditions are "admitted prior art" that render the asserted claims invalid. *See, e.g.*, Pinneo R. at ¶¶11333, 336-1338.

381. First, I disagree that the '189 patent admits these conditions are prior art. The passage states: "In fact, it has been shown that annealing of synthetic and natural type I or type II

diamonds in the range of 1900° C. To 2600° C. at pressures in the range of 50 to 80 kbars causes the visible color of diamond to change." '189 patent 1:34-38. The patent never refers to these conditions as "prior art," and did not specify who showed annealing in these ranges caused color change. I understand that, if this is a reference to work of the inventors, it is not prior art.

382. Regardless, these conditions do not render claims 1 or 2 of the '189 patent obvious. First, the listed conditions were used to anneal natural and "synthetic" diamond, not CVD diamond. Dr. Pinneo acknowledges that "synthetic" diamond in this passage refers to HPHT diamond, not CVD diamond. Pinneo R. at ¶1333. Second, the passage indicates that visible color was changed, which does not necessarily imply that optical clarity was improved. Accordingly, this passage from the patent fails to disclose "a method to *improve the optical clarity* of *CVD* diamond."

383. Likewise, because it pertained to natural and HPHT diamond, not CVD diamond, the passage from the patent fails to disclose "CVD diamond [that] is single crystal CVD diamond" or "raising a *CVD diamond* to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside the diamond stable phase."

384. For the same reason, the passage also fails to disclose "CVD diamond [that] is a single crystal coating upon another material" as required by claim 2 of the '189 patent.

385. Dr. Pinneo also asserts that "one skill in the art would have found even more motivation from the combined disclosures of Strong 690 and Strong 380 to try the annealing technique recited in claim 1 of the '189 patent with a single crystal CVD diamond because it had already been shown to have effectiveness with both natural and synthetic diamond." Pinneo R. at ¶1331. I disagree.

386. Strong 690 is a patent titled "Annealing Type Ib or Mixed Type Ib-Ia Natural diamond crystal" that listed inventors Herbert M. Strong, Richard R. Chrenko, and Roy E. Tuft,

and was assigned to General Electric Company when it issued on November 7, 1978. Strong 690 at 1 [45], [54], [73], [75]. According to the abstract, "[t]ype Ib or mixed type Ib-Ia natural diamond crystal is annealed" "to convert at least about 20% of the total amount of type Ib nitrogen present in the crystal to type Ia nitrogen," and all the patent claims are limited to natural diamond. *Id*. at 1 [57], claims 1-3.

387. Strong 380 is another patent listing the same three inventors that was also assigned to General Electric Company when it issued on November 13, 1979. Strong 380 at 1 [45], [73], [75]. Strong 38 is titled "Annealing Synthetic Type Ib Diamond," the abstract indicates that "[t]ype 1b synthetic diamond crystal is annealed" "to convert at least about 20% of the total amount of type Ib nitrogen present in the crystal to type Ia nitrogen," and the claims are limited to either "synthetic diamond crystal" or a "free annealed synthetically grown diamond crystal." *Id*. at 1 [54], [57], claims 1-12. It was known at the time that GE was synthetically manufacturing diamond using HPHT methods, not CVD methods, and skilled artisans would have understood references to "synthetic" diamond in Strong 380 to pertain exclusively to HPHT diamond. *See also* Pinneo R. at ¶314.

388. Therefore, because Strong 690 and Strong 380 pertain to natural and HPHT diamond, they fail to disclose a method to improve the optical clarity of *CVD* diamond" as required by claim 1 of the '189 patent. Strong 690, moreover, explains that, "[a]s a result of the present process, at least a portion of the crystal undergoes some change in color or shade, i.e., in a greenish-yellow crystal at least a portion changes toward the yellow or for a yellow crystal a portion becomes at least a shade lighter yellow, the extent of which depends on the extent of its conversion to type Ia." Strong 690 6:40-46. This same result is given in Strong 380 for "at least a portion of the synthetic type Ib crystal." Strong 380 6:49-55. Accordingly, because these patents report "some

color change" in natural and HPHT diamond, it is not clear that they disclose "a method to improve optical clarity" as required by claim 1 of the '189 patent.

389. Likewise, because they pertain to natural and HPHT diamond, not CVD diamond, Strong 690 and Strong 380 fail to disclose "CVD diamond [that] is single crystal CVD diamond" or "raising a *CVD diamond* to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside the diamond stable phase," as required by claim 1 of the '189 patent.

390. They also fail to disclose "CVD diamond [that] is a single crystal coating upon another material" as required by claim 2 of the '189 patent.

391. Finally, Dr. Pinneo claims that Reintz, a publication cited by three of the '189 patent inventors in a Patent Office declaration filed in 2002, renders the asserted claims invalid. *See, e.g.*, Pinneo at ¶¶1333, 1336-1338.

392. Reintz is a 2000 article from Gems & Gemology titled "Identification of HPHT-Treated Yellow to Green Diamonds." Reintz at 128. The authors were GIA Gem Trade employees who reported on analyses they performed on "treated-color natural diamonds." *Id*. They examined 63 natural diamonds from three companies that had been HPHT treated, and they presented some of their gemological and spectrospic properties. *Id*. at 128, 130. They also general describe the conditions at which two of the companies had HPHT treated the natural diamond samples. *Id*. at 136.

393. Because Reintz presents only analytical results for treated *natural* diamond samples, it fails to disclose "a method to improve the optical clarity of *CVD* diamond" as required by claim 1 of the '189 patent. Also, Reintz does not report on the actual HPHT annealing done on the samples and notes only that "[s]everal companies are now treating brown diamonds with high pressure and high temperature (HPHT) to transform their color to greenish yellow, yellowish green,

yellow, or brownish yellow." *Id*. at 128. Because the samples remained colored, it is not clear that Reintz discloses "a method to improve optical clarity" as required by claim 1 of the '189 patent.

394. Likewise, because it pertains to natural diamond, not CVD diamond, Reintz fails to disclose "CVD diamond [that] is single crystal CVD diamond" or "raising a *CVD diamond* to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside the diamond stable phase," as required by claim 1 of the '189 patent.

395. It also thus fails to disclose "CVD diamond [that] is a single crystal coating upon another material" as required by claim 2 of the '189 patent.

396. As explained above, moreover, there were several reasons why persons of skill in the art would not have been motivated to apply the natural or HPHT diamond annealing conditions to the CVD diamond or have had a reasonable expectation of success in doing so, even though the different types of diamond had certain similarities. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between the types (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond. In fact, Strong 690 and Strong 380 recognize that "there are enough difference between [synthetic and natural diamond] to distinguish between the natural and synthetic crystal," those being "mainly in morphology, surface appearance, impurity inclusions and the nature of impurity imperfections such as the different forms of nitrogen." Strong 690 1:42-48; Strong 380 1:47-53. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

397. Accordingly, the background section of the '189 patent, Strong 690, Strong 380, and Reintz (either alone or in view of a skilled artisan's knowledge) all fail disclose each element of claims 1 and 2 of the '189 patent, and therefore do not anticipate the claims. Likewise, there was no motivation to combine the background section of the '189 patent, Strong 690, Strong 380, or Reintz with a skilled artisan's knowledge of certain similarities between natural, HPHT, and CVD diamond to render these claims obvious, nor a reasonable expectation of success in combining these to reach the claimed methods.

1. *Anthony 2005* Does Not Anticipate Claims 1 and 2 of the '189 Patent

398. U.S. Patent No. 5,672,395 to Anthony et al. ("*Anthony 2005*") does not anticipate claims 1 and 2 of the '189 Patent.

399. *Anthony 2005* is a U.S. patent titled "Method for Enhancing the Toughness of CVD Diamond" that issued on September 30, 1997 to inventors Thomas R. Anthony, William F. Banholzer, Clifford L. Spiro, Steven W. Webb, and Bradley E. Williams. *Anthony 2005* at 1 [54], [75]. When it issued, *Anthony 2005* was assigned to General Electric Company. *Id*. at 1 [73]. According to the abstract, *Anthony 2005* pertains to a "method of treating as-grown chemical vapor deposited (CVD) starting diamond film having stresses and containing voids," where the method "comprises steps of subjecting the diamond film to a temperature of above about 1000° C and a hydrostatic pressure of above about 3 kilobars." *Id*. at 1 [57].

400. Like the abstract, the specification of *Anthony 2005* focuses on the treatment of CVD diamond films. A person of skill in the art reading *Anthony 2005* in 2002 would understand that CVD diamond films were typically polycrystalline material, and *Anthony 2005*'s disclosure confirms this throughout. For example, the patent notes "the polycrystalline nature of CVD diamond," seemingly implying that all CVD diamond is polycrystalline at the time of the filing. *Id*. 6:26. *Anthony 2005* also explains that "crystal size of the starting CVD diamond may vary

greatly and is dependent on the nucleation of diamond," *id*. 3:46-47, "[w]ith continued nucleation during the deposition process, submicron crystals may be obtained," *id*. 3:46-49, "elongated diamond crystals up to the length approximately equal to the film thickness may be formed," *id.* 3:49-52, and "CVD diamond for optical application typically has crystals with a <110> orientation perpendicular to the bottom surface," 8:10-12. The patent also explains that "the polycrystalline nature of diamond can result in light scatter which can interfere with clarity," and high refractive index "contributes to a reduction in transmittance." *Id*. 3:65-4:2 (emphasis added). "Hence, a starting CVD diamond having desirable clarity and refractive index [was] preferred" by the inventors. *Id*. 4:2-3.

401. In this latter passage, the inventors indicated the starting material for the patented methods was polycrystalline CVD diamond, since they had just explained that polycrystalline diamond could have the undesirable properties they sought to minimize in their starting material. By choosing starting material already with the desired clarity, moreover, the inventors showed they were not interested in improving optical clarity, as claimed in the '189 Patent. Claim 8 of *Anthony 2005* likewise is restricted to starting material that "is optically transparent." The purpose of the *Anthony 2005* methods was distinct—those methods were meant to improve mechanical properties like hardness and enhance "toughness," as seen in the patent's title. *Id*. at [54].

402. All the claims of *Anthony 2005*, moreover, are limited to the treatment of "as-grown chemical vapor deposited (CVD) polycrystalline starting diamond film," not single-crystal CVD diamond like the '189 patent. This confirms that *Anthony 2005* pertained to polycrystalline, not single crystal, CVD diamond.

403. In other passages, *Anthony 2005* further confirms the polycrystalline nature of the CVD diamond films at issue. It explains that "CVD films" "start out with fine grain size on the

initial nucleation surface" and the "grain size gradually expands." *Anthony 2005* 3:14-18; see also *id*. 3:46-52 ("nucleation of diamond;" "nucleation during the deposition process;" "initial nucleation at the substrate"); *id*. 8:12-17 ("diamond grains may have a random orientation;" "grain size of the CVD diamond is sufficiently small, random crystallographic orientations may be obtained"); claims 7, 8, 10. It then explains that "[g]rain boundaries between adjacent diamond crystals having hydrogen atoms saturating dangling carbons is preferred . . . ." *Id*. 3: 28-31. A person of skill in the art would understand these references to grain size, grain boundaries, and nucleation sites as indications that the CVD diamond film is polycrystalline. Prior to *Anthony* 2005 being filed, CVD was predominately used to grow polycrystalline film.

404. Prior to 1996, when *Anthony 2005* was filed, CVD was predominately used to grow polycrystalline films. As compared to single-crystal diamond, the microstructure of polycrystalline CVD is quite complex. *See Graebner*. The figure in *Graebner* reproduced below

shows that the size of diamond grains increases from bottom to the top.

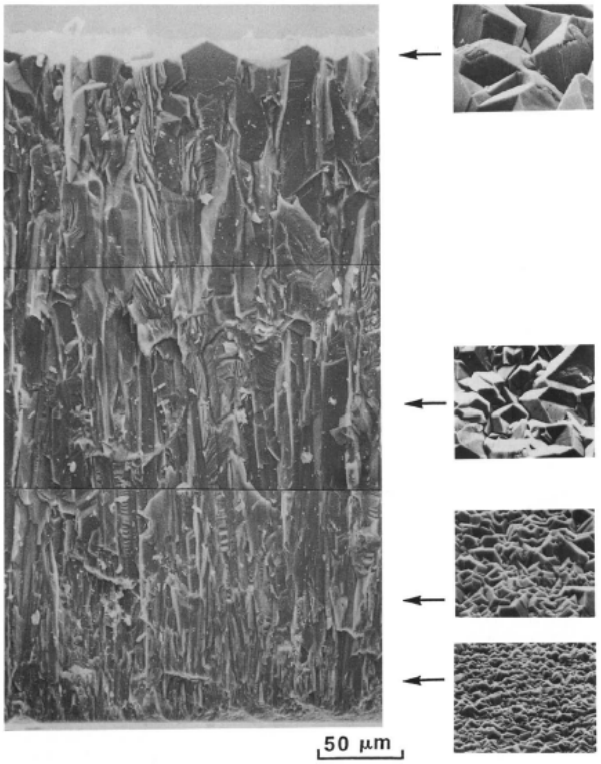
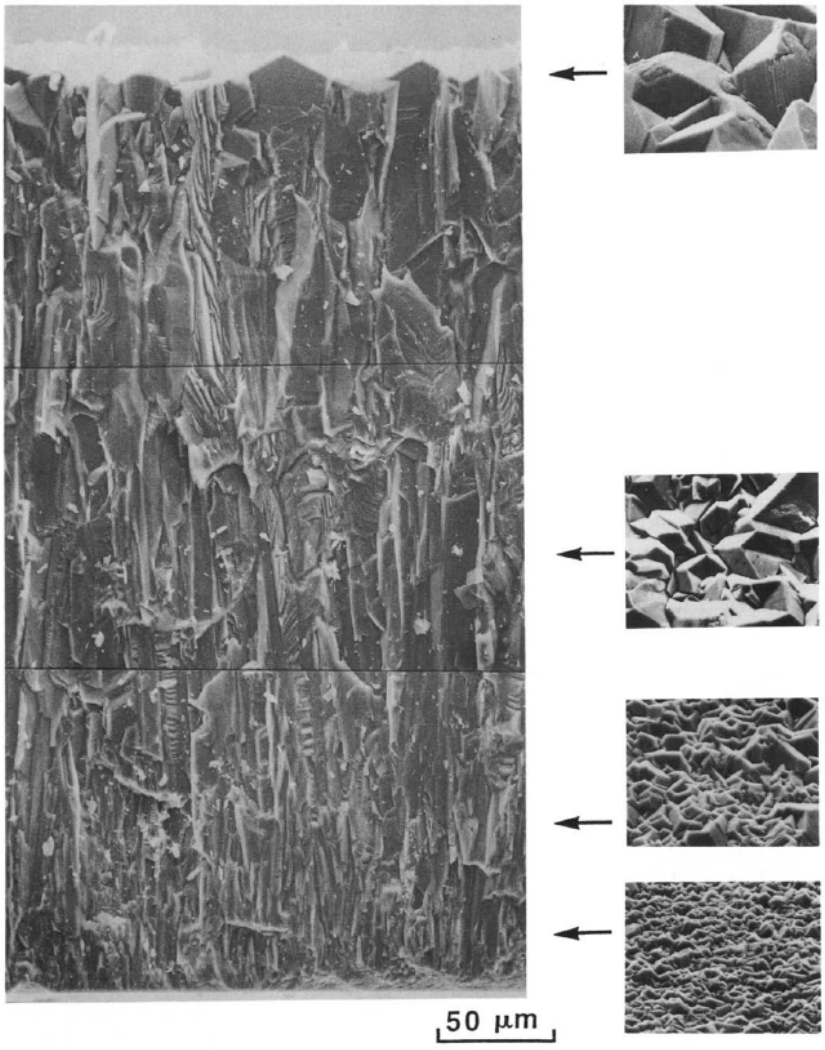


Fig. 1. Scanning electron micrograph of a CVD diamond sample, 355 µm thick (left). The columnar growth and increasing grain size from bottom to top are evident. Micrographs of the top surfaces of three samples are shown on the right.



Scanning electron micrograph of a CVD diamond sample, 355 gm thick (left). The columnar growth and increasing grain size from bottom to top are evident. Micrographs of the top surfaces of three samples are shown on the right. *Graebner* Fig. 1.

405. The measured thermal conductivity also increased from bottom to top, because at the top there are few grain boundaries to decrease transmission of heat. Graebner's fundamental insights were published in "Nature", a prestigious journal with an impact factor of ~43. *See* https://www.nature.com/nature/about/journal-metrics. Graebner's work also had a practical implication. High thermal conductivity polycrystalline diamond films were desired as heat spreaders for improving the thermal management of microelectronic devices. The concept was to deposit a layer of polycrystalline diamond onto the backside of a silicon wafer. The heat spreading

ability of the polycrystalline diamond could then be exploited for controlling the temperature of the microelectronic circuits which would be fabricated on the opposite side of the wafer. Thus, polycrystalline CVD films were of considerable interest for "diamond electronic components," a term used in *Anthony 2005* (7:56). In 2000, a review of CVD diamond for electronic applications appeared. *See Railker*. In addition to describing polycrystalline diamond films for heat spreading application, *Railker* notes (at 217):

> Despite the grain boundaries and defects in polycrystalline diamond films, electronic devices, such as MIS Schottky diodes, have been demonstrated as noted previously.[187, 201, 202] Kang et al. [187] have fabricated and characterized metal-insulator-semiconductor MIS Schottky diodes using thin-layered, polycrystalline diamond structures grown directly on conducting (tungsten) substrates.

406. At 1:38-46, *Anthony 2005* states:

> Polycrystalline diamond films prepared by CVD methods suffer from visual and mechanical defects associated with grain boundaries and growth defects including voids. In addition, residual stresses associated with the growth processes may be undesirable. Subsequent use of CVD polycrystalline diamond films in tool, electro-optical applications, and so on may be inhibited by the presence of these defects.

407. Thus, *Anthony 2005* clearly states that CVD polycrystalline diamond has use in electro-optical applications. In addition to the use of polycrystalline diamond in the thermal management of microelectronic components, free-standing polycrystalline diamond films are of interest for optical windows for high power lasers. *Anthony 2005* 1:27-37. This application has been commercialized. *See* https://www.edmundoptics.com/f/ii-vi-optical-grade-polycrystalline-cvd-diamond-windows/39550/. Polycrystalline diamond films were also envisioned as window for x-ray lithography, a technique for patterning small features in integrated circuits. Hence, x-ray lithography windows are another optoelectronic application for polycrystalline diamond.

408. Both the annealing behavior of diamond and the optical properties of diamond are dominated by numerous types of defects and impurities. It is obvious that the grain boundary structure of polycrystalline CVD diamond has different types of defects and defects at higher concentration levels than would be present in a single crystal diamond. Thus, a person of skill in the art would be surprised that annealing conditions that improve the mechanical properties of polycrystalline CVD diamond would increase the optical clarity of single crystal CVD diamond.

409. Irradiation can increase the defect concentrations in diamond. Some of the defects created by irradiation, such as the GR1 band, can be rapidly annealed out at relatively low temperatures producing correlated changes in color (420-60 0°C). *See Allers* at 228 and *Anthony 2005* (US2005/0260936) at [0012]. A person of skill in the art would be aware that prior to irradiation, much higher annealing temperatures (1700-2025°C) are typically used to improve optical clarity of unirradiated diamonds. *Collins* at 113 (FD468527). Thus, a person of skill in the art would be aware that annealing conditions for improving the optical clarity of diamond can be strongly dependent on the concentration of defects present. Thus, a person of skill in the art would be surprised that the same annealing conditions used for polycrystalline diamond would apply to single crystal diamond.

410. As discussed above and seen in the title, the *Anthony 2005* inventors sought to improve mechanical properties. They focused on intrinsic tensile stresses in CVD diamond, noting that "large intrinsic tensile stresses are typically present" and the "residual stresses associate with the growth process may be undesirable." *Id*. 1:15-16. They mentioned defects associated with grain boundaries, which along with "residual stresses," were the problems they sought to address. *Id.* 1:38-47; *see also id*. 2:7-11 ("Hence, a desirable advance in the art is to achieve enhanced stress reduction . . . ."); *id*. 2:51-55. If CVD diamond is heated briefly, they explained, "the large

deposition stresses can relax as plastic flow takes place and 90% of the stresses in CVD diamond can be eliminated." *Id*. 4:10-13. This "high temperature process for annealing CVD diamond" and relieving the stresses could "enhance the strength and desirable properties." *Id*. 1:61-64. Claim 6 thus indicates that the treated "CVD diamond film has reduced stresses." A person of skill in the art would therefore not view the methods of *Anthony 2005* as methods to improve optical clarity, like the methods of the '189 patent.

a. Claim 1

411. *Anthony 2005* fails to anticipate claim 1 of the '189 patent because it fails to disclose all its claim elements, and thus fails to disclose each element as arranged in claim 1. I take up each claim element in turn and explain why a person of ordinary skill in the art would not have interpreted *Anthony 2005* to disclose the element.

(i) 1[pre]: "A method to improve the optical clarity of CVD diamond"

412. While I understand that the preamble of claim 1 is not given a limiting effect under the Court's claim construction order, I will briefly assess it to provide as complete an opinion as possible. This assessment, however, is not necessary to reach my conclusion that *Anthony 2005* fails to anticipate claim 1. As explained below, *Anthony 2005* fails to disclose claim elements 1[a] and [b], and certainly does not disclose them as arranged in the claim. If a prior art reference fails to disclose each claim limitation as arranged in the claims, I understand it cannot anticipate.

413. Beyond that, it is also my view that *Anthony 2005* fails to disclose "a method to improve the optical clarity of CVD diamond." The *Anthony 2005* inventors were concerned with intrinsic stresses and voids within CVD diamond that resulted from the deposition process. *Id.* 1:38-47. The relief of these stresses, they explained, resulted in CVD diamond of enhanced

strength. *Id*. 1:61-64. There is no clear disclosure of treatment of single-crystal CVD diamond to improve optical clarity.

414. In fact, when *Anthony 2005* does mention clarity, it notes potential clarity issues with polycrystalline diamond starting material for the patented methods. That material is outside the scope of claims 1 and 2 of the '189 Patent, which are limited to single-crystal CVD diamond. (For this reason, as explained below, *Anthony 2005* fails to disclose limitation 1[a] of claim 1.). The inventors expressed a preference for polycrystalline starting material with desirable levels of clarity. *Id*. 4:2-3 ("Hence, a starting CVD diamond having desirable clarity and refractive index is preferred."). This confirms that *Anthony 2005* did not disclose "a method to improve the optical clarity of CVD diamond." The starting polycrystalline CVD diamond of *Anthony 2005* already had suitable clarity.

415. For these reasons, I believe that *Anthony 2005* fails to disclose "a method to improve the optical clarity of CVD diamond."

(ii) 1[a]: "where the CVD diamond is single crystal CVD diamond"

416. *Anthony 2005* pertains to HPHT treatment of polycrystalline CVD diamond film, not single crystal CVD diamond. As explained above, a person of skill in the art would view *Anthony 2005* as limited to the treatment of polycrystalline CVD diamond for several reasons. First, every claim is limited to "chemical vapor deposited (CVD) polycrystalline diamond starting film." *Id*. claims 1-11. Second, *Anthony 2005* also implies that all CVD diamond is polycrystalline. When explaining the physical changes that occur during high-temperature annealing, *Anthony 2005* describes the directional orientation of plastic yield by slip in CVD diamond: "Slip will occur on the four family of planes of the (111) type in the <110> direction plus one additional plane to accommodate the polycrystalline nature of CVD diamond." *Id*. 6:23-26.

417. Third, CVD diamond film is the consistent focus of the patent, and the patent consistently refers to CVD diamond film's "crystal size," "crystals," "grain size," "grain boundaries," "nucleation," and "nucleation surface." See, e.g., *id*. 3:46-52, 6:26. A person of ordinary skill in the art would view the use of these terms as indications that the contemplated CVD diamond material was polycrystalline.

418. Fourth, when the patent does mention single-crystal diamond, the context indicates that single crystal CVD diamond was not the material the *Anthony 2005* inventors sought to treat. Single-crystal material is mentioned only two times. The first is an introductory statement at the start of the patent that mentions thermal annealing of single- or polycrystalline diamond at a high level: "Thermal annealing may be utilized for reducing density fluctuations within an imperfect single- or polycrystalline body." *Id*. 1:51-53. This introductory statement makes no reference to CVD diamond, and from then on, the patent focuses on CVD diamond film with clear indications that CVD diamond film is polycrystalline. The second mention is in column 7, and it likewise is not in the context of CVD diamond. After several pages discussing CVD diamond, the patent states: "The present invention also contemplates improving the properties of other types of diamond parts, including single and polycrystalline diamond, specifically including diamond wire dies, tools and wear parts including friction-reducing diamond surfaces, diamond windows, heat sinks, diamond electronic components including those doped at annealing conditions, diamond grit for saws, drills and grinding tools." *Id*. 7:51-57. By introducing single crystal diamond as related to "other diamond parts" and by not mentioning CVD diamond, a person of skill in the art would view this passage as distinct from the methods of treating CVD diamond film discussed throughout the patent, and would not view the annealing conditions disclosed in the patent for the CVD diamond film as applying to single-crystal diamond for the long list of possible diamond parts.

419. In my opinion, Dr. Pinneo improperly focuses on these two sentences mentioning single crystal diamond and seems to improperly extend them to the entire disclosure. Pinneo R. ¶¶1344-1345. The questionable nature of his characterization is further exposed by his reliance on Figure 1, (*id*. ¶ 1349-50). This figure comes from DeVries, and Dr. Pinneo quotes the text from *Anthony 2005* indicating the source. *Id*. ¶ 1350 (quoting *Anthony 2005* 2:24-32). Dr. Pinneo focuses on one data point from DeVries's figure around 1560° C and 4 kilobar, and based on this data point, Dr. Pinneo claims that "one skilled in the art would have understood *Anthony 2005* to disclose this specific temperature-pressure combination and to teach it is one HPHT condition with which to practice the annealing technique *Anthony 2005* disclosed." *Id*. ¶ 1355. I disagree. DeVries was a study of "[s]ingle crystals (~ 1mm in largest dimension) of either naturally occurring (both Type I and Type II) or Man-Made diamonds (nitrogen in solid solution) [that] were embedded in Man-Made diamond powder (230-400 mesh) and squeezed in an internally heated, high pressure cell." DeVries at 1193. In my opinion, this material was not CVD single-crystal diamond, and a person of skill in the art in 2002 would recognize this. There is no indication in DeVries that the "Man-Made" diamond was CVD diamond, and this appears to be a reference to diamonds grown by GE in the 1970s, which were produced by HPHT methods. Moreover, the citations to DeVries in *Anthony 2005* relate exclusives to Figure 5 of DeVries (Figure 1 of *Anthony 2005*). But according to DeVries, "[t]hese data are predominantly from Type I natural diamonds." DeVries at 1197. A person of skill in the art would not view the figure as related to CVD single-crystal diamond or the citations in *Anthony 2005* as indications that *Anthony 2005* discloses methods of annealing single-crystal CVD diamond.

420. It is therefore my opinion that *Anthony 2005* fails to disclose element 1[a]. *Anthony 2005* also fails to disclose this element as arranged in that claim, namely, as CVD diamond that is

"single crystal CVD diamond" treated "to improve optical clarity" by "raising the CVD diamond" to the conditions specified in element 1[b].

(iii) 1[b]: "by raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase"

421. *Anthony 2005* also fails to disclose "raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside the diamond stable phase." Regarding "a set temperature of at least 1500°C," the claim requires this condition for CVD diamond that is single crystal CVD diamond. As explained above, *Anthony 2005*'s disclosures of temperature condition pertained to polycrystalline CVD diamond, not single crystal CVD diamond. The temperature conditions in claim element 1[b] at therefore not disclosed.

422. The same is true for the pressure condition of "at least 4.0 GPA outside of the diamond stable phase." The discussion of pressure ranges in *Anthony 2005* would be viewed by skilled artisans as disclosures of pressure conditions for polycrystalline CVD diamond. And even that discussion does not clearly disclose a pressure of at least 4.0 GPA (which is 40 kilobars). *Anthony 2005* distinguishes an abandoned patent application by the same inventors that disclosed HPHT annealing with pressures of 45 to 100 kilobars. *Id* 1:65-2:5. The abandoned application, *Anthony 2005* explains, involved annealing "carried out at pressure above the diamond-graphite line," whereas *Anthony 2005* involved "CVD diamond being annealed at pressure and temperature below the diamond-phase equilibrium line," that is, "lower pressures [were] utilized." *Id*. 7:21-26. *Anthony 2005* disclosed pressures "as low as 5 kilobars," and the inventors emphasized the "great economic advantage to operate pressure lower than 20 kilobars where steel alloy fixtures can be used in place of expensive tungsten carbide parts in the pressure apparatus." *Id*. 7:26-33. By emphasizing the use of pressures as low as 5 kilobars (0.5 GPA), encouraging pressures lower than 20 kilobars (2 GPA), and distinguishing a pressure range of 45 to 100 kilobars (4.5 to 10 GPA) for

polycrystalline CVD diamond, *Anthony 2005* does not provide a disclosure of pressures of at *least 4.0 GPA* for single crystal CVD diamond.

423. Dr. Pinneo also relies on Figure 1 of *Anthony 2005*, which is a copy of Figure 5 of *DeVries*. For the reasons explained above, the citations to *DeVries* would not be viewed by skilled artisans as related to single-crystal CVD diamond, nor as necessarily applicable to that material. *DeVries* used both natural and man-made diamond, there is no indication that any material was produced by CVD, and the "Man-Made" diamond appears to refer to HPHT grown diamond from GE. *DeVries* at 1193. Dr. Pinneo points to a single data point on Figure 1, but there is no indication that data is of "Man-Made" synthetic diamond, even if it were, it would pertain to HPHT not CVD diamond, and it likely is data for natural diamond. According to *DeVries*, "[t]hese data [in Figure 5] are predominantly from Type I natural diamonds." *DeVries* at 1197. It certainly is not a data point for a CVD single crystal diamond.

424. It is therefore my opinion that *Anthony 2005* fails to disclose element 1[b]. *Anthony 2005* also fails to disclose this element as arranged in that claim, namely, as CVD diamond that is "single crystal CVD diamond" treated "to improve optical clarity" by "raising the CVD diamond a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase."

b. Claim 2

425. *Anthony 2005* fails to anticipate claim 2 of the '189 patent because it fails to disclose all the elements of claim 1, from which claim 2 depends, and thus fails to disclose each element as arranged in claim 1. It also fails to disclose the additional element of claim 2, as explained below.

c. 2: "The method of claim 1 wherein the CVD diamond is a single crystal coating upon another material." [Add as heading

426. As discussed above, *Anthony 2005* fails to disclose CVD diamond that is single crystal CVD diamond. It is therefore my opinion that it fails to disclose CVD diamond that "is a single crystal coating upon another material." The two times *Anthony 2005* even mentions single-crystal diamond, it does not indicate that the single-crystal diamond was produced by CVD, does not disclose HPHT treatment for single crystal CVD diamond, and does not describe a single crystal coating upon another material.

2. Webb Does Not Anticipate Claims 1 and 2 of the '189 Patent

427. S.W. Webb et al., "Synthetic diamond crystal strength enhancement through annealing at 50 kbar and 1500 C," 10 J. Matter. Res. (1996) ("Webb") does not anticipate Claims 1 and 2 of the '189 Patent.

428. Webb is a 1995 paper by two authors from GE Superabrasives. It reports on certain effects of HPHT annealing on the crystal strength of "synthetic type I diamond crystals," Webb at 1700, which were specified as "synthetic, single-crystal, saw-grade products, with cubo-octohedral shapes in the 40/50 mesh (425-300 μm) range," *id*. at 1702. The reference to a cubooctahedral shape implies that these crystals were produced by HPHT methods, not CVD.

429. Other facts confirm the HPHT nature of the tested material. For example, Webb explains that "[a]ll crystals contain included nitrogen and metal impurities," *id*., and that "[i]ncluded metal arises due to the metal-catalyst system from which the crystal was grown," *id.* at 1700. It was known in the field that GE synthesized diamond by HPHT processes in which graphite was dissolved with a molten metal (nickel, cobalt, or iron) that acted as a solvent and catalyst. [CITE] A person of skill in the art would thus understand that Webb used HPHT synthesized diamond. *Badding* at 163 (noting "important questions" regarding HPHT synthesis

technology "such as the mechanism by which transition metals catalyze the transformation of graphite to diamond (or vice versa)");

430. I therefore disagree with Dr. Pinneo's view that skilled artisans "would have understood that Wood's reference to 'synthetic' diamond included a mand-made diamond d produced using CVD," Pinneo R. at ¶1366; *see also id*. ¶¶ 1370, 1379. I also disagree with his claim that skilled artisans "would have understood that CVD diamond has similar characteristics to HPHT diamond and a natural diamond." *Id*. As I discussed above, there were there were many known differences between natural, HPHT, and CVD diamond, particularly ones that affect annealing mechanisms. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between the types (e.g., metal inclusions, incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond.

431. Webb examines the effect of HPHT annealing on crystal strength of HPHT synthetic diamond. Webb concludes that "HPHT annealing appears to provide significant improvement in crystal strength," but only for certain crystals because of the "very complex lattice chemistry of annealing nitrogen-included diamond" that is "confounded by concurrent metal aggregation." *Id*. at 1708. Because graphitization was a concern with the metal-included HPHT material examined, Webb explained that "plastic strain reduction due to annealing must outweigh any local strain increase due to internal graphitization" "to produce strong crystal," thus indicating that any motivation to apply HPHT annealing techniques depends strongly on the chemical and mechanical properties of the material being treated. Webb at 1700. In fact, Webb stated: "Clearly, from this work, there are many characteristics of synthetic diamond that dictate its propensity to

be annealed, such as content of metal, graphite, nitrogen, stress states, internal and surface defects, etc." *Id*. at 1705.

432. While Webb notes that "[a]nnealing studies of diamond have been used to alter optical properties by aggregation of grown-in nitrogen, or other impurities, added either intentionally or unintentionally to the synthesis system," *id*. at 1701, and Webb presents some spectroscopic analyses, *id*. at 1702-1704, Webb was concerned with the effects on mechanical properties, not optical properties. A person of skill in the art would not view Webb as seeking to improve optical clarity of CVD diamond, as claimed in the '189 patent. To imply the opposite, Dr. Pinneo focuses on the description of past annealing studies to alter optical properties. Pinneo R. at ¶1367. But Webb stated that these studies were conducted on "diamond," not specifying if it was natural or HPHT diamond, and a skill artisan would not interpret the past studies to have included CVD diamond. Webb's explanation that optical "properties" were "altered," moreover, would not be viewed as a disclosure that optical "clarity" was "improved."

433. Finally, although Webb explained that "annealing experiments were done in a HPHT cell at approximately 55 kbar pressure," pressure "were not directly measured, but we inferred by the lack of diamond backconversion on crystal surfaces." *Id*. at 1702. The accuracy of Webb's estimate is unknown and the lack of back-conversion may have resulted from conditions in the diamond stable phase, not outside the diamond stable phase are required by the claims of the '189 patent.

a. Claim 1

434. Webb fails to anticipate claim 1 because it fails to disclose all its claim elements, and thus fails to disclose each element as arranged in claim 1. I take up each claim element in turn and explain why a person of ordinary skill in the art would not have interpreted Webb to disclose the element.

(i) 1[pre]: "A method to improve the optical clarity of CVD diamond"

435. While I understand that the preamble of claim 1 is not given a limiting effect under the Court's claim construction order, I will briefly assess it to provide as complete an opinion as possible. This assessment, however, is not necessary to reach my conclusion that Webb fails to anticipate claim 1. As explained below, Webb fails to disclose claim elements 1[a] and [b], and certainly does not disclose them as arranged in the claim. If a prior art reference fails to disclose each claim limitation as arranged in the claims, I understand it cannot anticipate.

436. Beyond that, it is also my view that Webb fails to disclose "a method to improve the optical clarity of CVD diamond." First, as explained above, Webb pertains to "synthetic diamond" made by HPHT methods, not CVD methods, as evident from the metal inclusions and cubo-octahedral geometry described in Webb. Webb at 1702.

437. Webb, moreover, was concerned with crystal strength, not optical properties, of the HPHT diamond, and potential improvement to crystal strength through HPHT annealing techniques. See., e.g., *id*. at 1700 (title), 1707 (conclusions). There is no clear disclosure of HPHT annealing of single-crystal CVD diamond to improve optical clarity.

438. For these reasons, I believe Webb fails to disclose "a method to improve the optical clarity of CVD diamond."

(ii) 1[a]: "where the CVD diamond is single crystal CVD diamond"

439. Webb pertains to HPHT annealing of single-crystal HPHT diamond, not CVD diamond. As explained above, a person of skill in the art would view Webb as limited to the treatment of HPHT diamond for several reasons, including Webbs description of metal inclusions and cubo-octahedral geometry. Webb at 1702.

440. It is therefore my opinion that Webb fails to disclose element 1[a]. *Anthony 2005* also fails to disclose this element as arranged in that claim, namely, as CVD diamond that is "single crystal CVD diamond" treated "to improve optical clarity" by "raising the CVD diamond" to the conditions specified in element 1[b].

(iii) 1[b]: "by raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase"

441. Webb also fails to disclose "raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside the diamond stable phase." Regarding "a set temperature of at least 1500 °C," the claim requires this condition for CVD diamond. As explained above, Webb discloses annealing conditions used on HPHT diamond, not CVD diamond. The temperature conditions for CVD diamond in claim element 1[b] at therefore not disclosed.

442. The same is true for the pressure condition of "at least 4.0 GPA outside of the diamond stable phase." Webb disclosed pressure conditions for HPHT diamond, not CVD diamond. And even that disclosure does not clearly describe a pressure of at least 4.0 GPA (which is 40 kilobars). Webb estimated that the HPHT annealing experiments were done at "approximately" 55 kbar, failing to provide precise conditions because "[p]ressures were not directly measure, but were inferred by the lack of diamond backconversion on crystal surfaces." Webb at 1702. A person of skill in the art would recognize the imprecision of this disclosure and would suspect that the annealing experiments we conducted in the diamonn-stable phase, thus resulting in no back conversion. I therefore disagree with Dr. Pinneo's assertion that Webb discloses the claimed pressure conditions and annealing conditions outside of the diamond stable phase. *See, e.g.*, Pinneo R. at ¶1373.

443. It is my opinion that Webb fails to disclose element 1[b]. Webb also fails to disclose this element as arranged in that claim, namely, as CVD diamond that is "single crystal CVD

diamond" treated "to improve optical clarity" by "raising the CVD diamond a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase."

b. Claim 2

444. Webb fails to anticipate claim 2 of the '189 patent because it fails it fails to disclose all the elements of claim 1, from which claim 2 depends, and thus fails to disclose each elements as arranged in claim 1. It also fails to disclose the additional element of claim 2, as explained below.

(i) 2: "The method of claim 1 wherein the CVD diamond is a single crystal coating upon another material." [Add as heading

445. As discussed above, Webb fails to disclose CVD single crystal diamond because it involved experiments on HPHT single crystal diamond. It is therefore my opinion that it fails to disclose CVD diamond that "is a single crystal coating upon another material." In fact, the HPHT diamond used "saw diamond'" Webb at 1700, which would not be a coating upon another material.

3. Anthony 2005 and Webb Does Not Render Obvious Claims 1 and 2 of the '189 Patent

446. Dr. Pinneo asserts that the combination of *Anthony 2005* and Webb renders claims 1 and 2 of the '189 patent obvious. Pinneo R. at ¶1383. I disagree for the reasons below.

a. No Motivation to Combine

447. As an initial matter, there was no motivation to combine *Anthony 2005*, which pertains to polycrystalline CVD file (as explained above), with Webb, which pertains to HPHT synthetic diamond (as also explained above). Nor would a person of ordinary skill in the art have a reasonable expectation of success in achieving the claimed invention (methods to improve optical clarity of CVD single crystal diamond) by combining *Anthony 2005* and Webb. At the time of the invention, there were several known differences between HPHT, polycrystalline CVD, and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to

differ, there were known compositional differences between them (e.g., incorporated hydrogen content), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond. I thus disagree with Dr. Pinneo's claim that a "skilled artisan would have recognized that the synthetic single crystal CVD diamond disclosed in *Anthony 2005* would obtain the benefit of the specific pressure and temperature condition of 50 k bar and 15000 oC as disclosed in Webb to obtain strength enhancement." Pinneo R. at ¶1388.

448. Furthermore, there would have been no motivation to apply *Anthony 2005* and Webb to reach the claimed invention. As Dr. Pinneo recognizes, both references are "concerned with providing a synthetic diamond with increased strength." Pinneo at 1386. The claims of the '189 patent, by contrast, are directed to improving optical clarity. These differing goals, combined with the known structural and compositional differences between HPHT, polycrystalline CVD, and single crystal CVD diamond, would have prevented any motivation to combine or reasonable expectations of success.

b. Claim 1

449. Beyond the lack of motivation or reasonable expectation of success for *Anthony 2005* and Webb, the references also fail to disclose the claim elements. As explained below, *Anthony 2005* pertains to polycrystalline CVD film, not single crystal CVD diamond, and thus fails to disclose certain claim elements. Webb pertains to HPHT synthetic diamond, not single crystal CVD diamond, and therefore also fails to disclose certain claim elements. The combination of *Anthony 2005* and Webb thus fails to render claim 1 obvious.

(i) 1[pre]: "A method to improve the optical clarity of CVD diamond"

450. While I understand that the preamble of claim 1 is not given a limiting effect under the Court's claim construction order, I will briefly assess it to provide as complete an opinion as possible. This assessment, however, is not necessary to reach my conclusion that the combination of *Anthony 2005* and Webb fails to render claim 1 obvious. As explained below, *Anthony 2005* and Webb fail to disclose claim elements 1[a] and [b] whether considered alone or in combination, and there was no motivation to combine these references or reasonable expectation of success in achieving the claimed methods, as explained above. Beyond that, it is also my view that the combination of *Anthony 2005* and Webb fails to disclose "a method to improve the optical clarity of CVD diamond."

451. First, as explained above, Webb is not directed to CVD diamond. It pertains to synthetic diamond made by HPHT methods. See, e.g., Webb at 1702. While *Anthony 2005* focuses on CVD polycrystalline diamond, it does not disclose methods of annealing single crystal CVD diamond. Thus, neither reference pertains to single crystal CVD diamond.

452. Moreover, as discussed above, *Anthony 2005* and Webb were directed to methods of improving the mechanical strength of polycrystalline CVD film (*Anthony 2005*) and HPHT synthetic diamond (Webb). Dr. Pinneo recognizes their purpose. Pinneo R. at ¶1386. Neither discloses a method "to improve optical clarity" of CVD diamond. Dr. Pinneo seems to acknowledge that Webb fails to disclose singe crystal CVD diamond by relying only on *Anthony 2005* for this claim element. Pinneo R. at ¶1395.

453. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to combine the polycrystalline CVD methods of *Anthony 2005* to with the single crystal CVD diamond methods of Webb to anneal single crystal CVD diamond.

Nor would such a person have had a reasonable expectation of success in doing so, even though the materials are all diamond and were known to have certain similarities. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

454. Accordingly, there was no motivation to combine *Anthony 2005* and Webb to render this element obvious, nor a reasonable expectation of success in so doing.

(ii) 1[a]: "where the CVD diamond is single crystal CVD diamond"

455. *Anthony 2005* and Webb both fail to disclose this claim element and, even if combined, do not render it obvious. As explained above, *Anthony 2005* pertains to polycrystalline CVD film (see, e.g., *Anthony 2005* at 1 [57], 2:51-3:63, 8:30-58, claims 1-11) and Webb pertains to synthetic diamond made by HPHT methods (see, e.g., Webb at 1702). Neither pertains to "single crystal CVD diamond." Whether alone or in combination, they fail to disclose "CVD diamond [that] is single crystal CVD diamond." I thus disagree with Dr. Pinneo's claim that both references disclose methods for single crystal CVD diamond. Pinneo R. at ¶¶1396-1397.

456. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to combine the polycrystalline CVD methods of *Anthony 2005* with the HPHT diamond methods of Webb to anneal single crystal CVD diamond as claimed in the '189 patent. Nor would such a person have had a reasonable expectation of success in doing so, even

though the materials are all diamond and were known to have certain similarities. At the time, there were several known differences between HPHT, polycrystalline CVD, and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond. Dr. Pinneo is mistaken when he says "one skilled in the art would have had a reasonable expectation of success in using the *Anthony 2005* annealing technique with a single crystal CVD diamond to achieve the predictable result of strength enhancement." Pinneo R. at ¶1398.

457. Accordingly, there was no motivation to combine *Anthony 2005* and Webb to render this element obvious, nor a reasonable expectation of success in so doing.

(iii) 1[b]: "by raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase"

458. *Anthony 2005* and Webb both fail to disclose this claim element and, even if combined, do not render it obvious. The claim requires these conditions for CVD diamond that is single crystal CVD diamond. As explained above, Webb pertains to synthetic diamond made by HPHT methods (see, e.g., Webb at 1702), not CVD diamond. *Anthony 2005* focuses on polycrystalline CVD film (see, e.g., *Anthony 2005* at 1 [57], 2:51-3:63, 8:30-58, claims 1-11), not single crystal CVD diamond as claimed.

459. Furthermore, whether alone or in combination, they fail to disclose the claimed conditions. For example, while *Anthony 2005* mentions certain temperature and pressure ranges,

it emphasizes the use of pressures as low as 5 kilobars (0.5 GPa), encourages pressures lower than 20 kilobars (2 GPa), and distinguishing a pressure range of 45 to 100 kilobars (4.5 to 10 GPa). See, e.g., *Anthony 2005* 1:65-2:5, 7:26-33. The discussion of pressure ranges in *Anthony 2005*, moreover, would be viewed by skilled artisans as disclosures of pressure conditions for polycrystalline CVD diamond, not single crystal CVD diamond as claimed. *Anthony 2005* thus fails to disclose pressures of at *least 4.0 GP*afor single crystal CVD diamond.

460. While Webb discloses pressure conditions for HPHT diamond, not CVD diamond, that disclosure does not clearly describe a pressure of at least 4.0 GPa (which is 40 kilobars). As discussed above, Webb provided an approximate pressure value of 55 kbar because "[p]ressures were not directly measured, but were inferred by the lack of diamond backconversion on crystal surfaces," Webb at 1702, and a person of skill in the art would suspect the conditions were in the diamond-stable phase since there was no back conversion.

461. Dr. Pinneo relies on Figure 1 of *Anthony 2005*, Pinneo R. at ¶1402, which is a copy of Figure 5 of *DeVries*. For the reasons explained above, *DeVries* would not be viewed by skilled artisans as related to single-crystal CVD diamond, nor as necessarily applicable to that material. *DeVries* used both natural and HPHT diamond, *DeVries* at 1193, and the data in Figure 1 "are predominantly from Type I natural diamonds," *id*. at 1197. It certainly is not a data for single crystal CVD diamond.

462. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to combine the polycrystalline CVD methods of *Anthony 2005* with the HPHT diamond methods of Webb to anneal single crystal CVD diamond as claimed in the '189 patent. Nor would such a person have had a reasonable expectation of success in doing so, even though the materials are all diamond and were known to have certain similarities. At the time,

there were several known differences between HPHT, polycrystalline CVD, and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

463. Accordingly, there was no motivation to combine *Anthony 2005* and Webb to render this element obvious, nor a reasonable expectation of success in so doing.

c. Claim 2

464. The combination of *Anthony 2005* and Webb fails to render claim 2 obvious. Anthony-4 pertains to polycrystalline CVD film and Webb pertains to HPHT diamond, not CVD single crystal diamond, and therefore both fail to disclose the additional element of claim 2. There was also no motivation to combine *Anthony 2005* and Webb and no reasonable expectation of success in doing so.

(i) 2: "The method of claim 1 wherein the CVD diamond is a single crystal coating upon another material." [Add as heading

465. *Anthony 2005* and Webb both fail to disclose this claim element and, even if combined, do not render it obvious. As explained above, *Anthony 2005* pertains to polycrystalline CVD film (see, e.g., *Anthony 2005* at 1 [57], 2:51-3:63, 8:30-58, claims 1-11) and Webb pertains to synthetic diamond made by HPHT methods (see, e.g., Webb at 1702). Neither pertains to single crystal CVD diamond. Whether alone or in combination, they fail to disclose "CVD diamond is a single crystal coating upon another material." I thus disagree with Dr. Pinneo's claim that *Anthony*

2005 discloses this claim element. Pinneo R. at ¶1405. By relying only on *Anthony 2005*, moreover, Dr. Pinneo appears to concede that Webb does not pertain to CVD diamond. *Id*. ¶¶ 1405-1407.

466. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to combine the polycrystalline CVD methods of *Anthony 2005* with the HPHT diamond methods of Webb to anneal single crystal CVD diamond as claimed in the '189 patent. Nor would such a person have had a reasonable expectation of success in doing so, even though the materials are all diamond and were known to have certain similarities. At the time, there were several known differences between HPHT, polycrystalline CVD, and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during the pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

467. Accordingly, there was no motivation to combine *Anthony 2005* and Webb to render this element obvious, nor a reasonable expectation of success in so doing.

4. Webb Does Not Render Obvious Claims 1 and 2 of the '189 Patent

468. Dr. Pinneo asserts that Webb, in combination with the knowledge of one skilled in the art, renders claims 1 and 2 of the '189 patent obvious. Pinneo R. ¶1408. I disagree for the reasons below.

a. No Reason to Use Webb's disclosures on Single Crystal CVD diamond

469. As an initial matter, it would not have been obvious at the time of the invention to try the annealing methods of Webb, which pertain to HPHT synthetic diamond (as explained above), to single-crystal CVD diamond, or any motivation to do so. Nor would a person of ordinary skill in the art have had a reasonable expectation of success in achieving the claimed invention (methods to improve optical clarity of CVD single crystal diamond) from Webb's methods to improve the crystal strength of HPHT diamond. At the time of the invention, there were several known differences between HPHT and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond. I thus disagree with Dr. Pinneo's claim that a person of skill in the art would have been motivated by "the similar composition and properties of different kinds of synthetic diamond," or his assertion that "a CVD diamond has comparable chemical, physical and optical properties as a HPHT diamond." Pinneo R. at ¶¶1408, 1412, 1415-1416, 1418, 1420, 1423. I also believe he is wrong to assert it would have "obvious to try" "obvious to apply" Webb to single-crystal CVD diamond, or that there was a motivation to do so or reasonable expectation of success in achieving the claimed methods. Pinneo R. at ¶¶1410-1414.

470. Furthermore, I disagree with Dr. Pinneo reliance (Pinneo R. at ¶1411) on Webb's exploration of methods to strengthen HPHT diamond for his assessment of the '189 patent, which

pertains to improvements of optical clarity of single crystal CVD diamond. These differing goals, combined with the known structural and compositional differences between HPHT and single crystal CVD diamond, would have prevented any motivation to combine or reasonable expectations of success.

b. Claim 1

471. Beyond the lack of motivation or reasonable expectation of success, Webb also fails to disclose the elements of claim 1. As explained throughout, Webb pertains to HPHT synthetic diamond, not single crystal CVD diamond. Dr. Pinneo acknowledges Webb's shortcoming by applying an obviousness theory to Webb, in addition to an anticipation theory. Obviousness, as I understand, is pertinent when a reference fails to disclose certain claim elements. For example, Dr. Pinneo believes it would have been obvious to grow a CVD diamond "in addition to (or substituted for) the 'synthetic diamond' in Webb to provide the method recited in claims 1 and 2 of the '189 patent." Pinneo R. at ¶1410. Webb thus fails to render claim 1 obvious.

(i) 1[pre]: "A method to improve the optical clarity of CVD diamond"

472. While I understand that the preamble of claim 1 is not given a limiting effect under the Court's claim construction order, I will briefly assess it to provide as complete an opinion as possible. This assessment, however, is not necessary to reach my conclusion that Webb fails to render claim 1 obvious. As explained below, Webb fail to disclose claim elements 1[a] and [b] whether considered alone or in combination with skilled artisan knowledge, and there was no motivation to apply Webb to single-crystal CVD diamond, or reasonable expectation of success in achieving the claimed method. Beyond that, it is also my view that Webb fails to disclose "a method to improve the optical clarity of CVD diamond."

473. As explained above, Webb is not directed to CVD diamond. It pertains to synthetic diamond made by HPHT methods. See, e.g., Webb at 1702. Moreover, as discussed above, Webb was directed to methods of improving the mechanical strength of HPHT synthetic diamond. Dr. Pinneo recognizes Webb's purpose. Pinneo R. at ¶¶1386, 1411. It does not disclose a method "to improve optical clarity" of CVD diamond.

474. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the HPHT diamond methods of Webb to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between HPHT and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

475. Accordingly, there was no motivation to apply Webb, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

(ii) 1[a]: "where the CVD diamond is single crystal CVD diamond"

476. Webb fails to disclose this claim element and, even if combined with skilled artisan knowledge, does not render it obvious. As explained above, Webb pertains to synthetic diamond

made by HPHT methods (*see, e.g.*, Webb at 1702), not "single crystal CVD diamond." Whether alone or in combination with skilled artisan knowledge, it fails to disclose "CVD diamond [that] is single crystal CVD diamond." I thus disagree with Dr. Pinneo's claim that Webb would have been understood "to disclose a method relating to CVD diamond where the CVD diamond is single crystal CVD diamond." Pinneo R. at ¶1419.

477. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to combine the HPHT diamond methods of Webb to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between HPHT and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond. Dr. Pinneo is mistaken to say that "one skilled in the art would have had a reasonable expectation of success in using the Webb annealing technique with a single crystal CVD diamond to achieve the predictable result of strength enhancement." Pinneo R. at ¶1420.

478. Accordingly, there was no motivation to apply Webb, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

(iii) 1[b]: "by raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase"

479. Webb fails to disclose this claim element and, even if combined skilled artisan knowledge, does not render it obvious. The claim requires these conditions for CVD diamond that is single crystal CVD diamond. As explained above, Webb pertains to synthetic diamond made by HPHT methods (see, e.g., Webb at 1702), not CVD diamond.

480. Furthermore, whether alone or in combination skilled artisan knowledge, Webb fails to the disclose the claimed conditions. While Webb discloses pressure conditions for HPHT diamond, not CVD diamond, that disclosure does not clearly describe a pressure of at least 4.0 GPA (which is 40 kilobars). As discussed above, Webb provided an approximate pressure value of 55 kbar because "[p]ressures were not directly measured, but were inferred by the lack of diamond backconversion on crystal surfaces," Webb at 1702, and a person of skill in the art would suspect the conditions were in the diamond-stable phase since there was no back conversion.

481. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the HPHT diamond methods of Webb to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between HPHT and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged

high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

482. Accordingly, there was no motivation to apply Webb, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

c. Claim 2

483. Webb fails to render claim 2 obvious. Webb pertains to HPHT diamond, not CVD single crystal diamond, and therefore fails to disclose the additional element of claim 2. There was also no motivation to apply Webb, whether alone or in combination with skilled artisan knowledge, to single-crystal CVD diamond or a reasonable expectation of success in doing so.

(i) 2: "The method of claim 1 wherein the CVD diamond is a single crystal coating upon another material."

484. Webb fails to disclose this claim element and, even if combined with skilled artisan knowledge, does not render it obvious. As explained above, Webb pertains to synthetic diamond made by HPHT methods (see, e.g., Webb at 1702), not single-crystal CVD diamond. Whether alone or in combination with skilled artisan knowledge, Webb fails to disclose "CVD diamond is a single crystal coating upon another material." I thus disagree with Dr. Pinneo's claim that Webb would be understood to "disclose that 'the CVD diamond is a single crystal coating upon another material.'" Pinneo R. at ¶1424.

485. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the HPHT diamond methods of Webb to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between HPHT and single crystal CVD diamond.

The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for HPHT diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

486. Accordingly, there was no motivation to apply Webb, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

5. Vagarali Does Not Anticipate or Render Obvious Claims 1 and 2 of the '189 Patent

487. U.S. Patent Application Pub. No. 2001/0031237 ("Vagarali") does not anticipate or render obvious claims 1 and 2 of the '189 Patent.

488. Vagarali is a patent application titled "High Pressure/High Temperature Production of Colorless and Fancy Colored Diamond." Vagarali cover page at [54]. It is "directed to a method of treating discolored natural diamond, especially Type IIa diamond and Type IaA/B diamond with nitrogen as predominantly B centers, to improve its color." *Id*. cover page at [57]. It published on October 18, 2001 and was filed on September 28, 1998. *Id*. cover page at [43], [22].

489. Although Vagarali lists typical temperature and pressure condition, as well as pressing times, it explains that the "conditions (time, temperature, and pressure) are correlated and adjusted to the nature of the discoloring defect in the diamond which have to be altered in order to improve color." *Id*. ¶ 22; see also *id*. ¶ 33 ("Annealing conditions depend upon the nature of the defect in the diamond which have to be removed or changed to improve color and can readily be

determined by those skilled in the art without undue experimentation."). While an advantage of the disclosed methods was to "upgrade color" or "make colorless diamond," it is not clear that the methods were intended to improve optical clarity. *Id*. ¶ 23. A listed advantage was only "the ability to retain optical clarity of treated diamonds disclosed herein." *Id*.

490. Every claim in Varagali is limited to "discolored natural diamond," *id*. claims 1-15, and every example involved natural diamond, *id*. ¶¶ 41-46. CVD diamond is never mentioned even though CVD synthesis of diamond was known at the time. Dr. Pinneo is therefore incorrect to assert that "one skilled in the art could have understood that Vagarali's reference to 'Type IIa diamond' would apply equally to either a natural or a synthetic diamond meeting the compositional definition of Type IIa" or "understood Vagarali to disclose a method for treating Type IIa single crystal CVD diamonds when expressly discussing the results of annealing natural IIa diamonds." Pinneo R. at ¶1430; see also *id*. ¶¶ 1436, 1438, 1441, 1455.

491. Dr Pinneo asserts that Vagarali renders claims 1 and 2 of the '189 Patent obvious if not anticipated. Pinneo R. at ¶1433. I disagree for the reasons below, including Vagarali's failure to disclose claim elements requiring single crystal CVD diamond (Vagarali pertains to natural diamond). Dr. Pinneo acknowledges Vagaralis' shortcoming by applying an obviousness theory to Vagalari, in addition to an anticipation theory. Obviousness, as I understand, is pertinent when a reference fails to disclose certain claim elements. For example, Dr. Pinneo believes it would have been obvious to grow a CVD diamond "in addition to (or substituted for) the 'Type IIa diamonds' in Vagarali to provide the method recited in claims 1 and 2 of the '189 patent." Pinneo R. at ¶1428. Vagarali fails to disclose several elements of claims 1 and 2 of the '189 patent, and fails to disclose all the elements as arranged in the claims. Vagarali therefore cannot anticipate the claims. For the reasons below, moreover, Vagarali fails to render the claims obvious whether alone or combined

with skilled artisan knowledge. Before I compare Vagarali's disclosures to the claim elements, I explain why a skilled artisan would not have been motived to apply Vagarali to single crystal CVD diamond or would have had a reasonable expectation to success in achieving the claims methods.

a. No Reason to Use Vagarali's disclosures on Single Crystal CVD diamond

492. A skilled artisan would not have found it obvious at the time of the invention to try the annealing methods of Vagarali, which pertain to natural diamond, to single-crystal CVD diamond, or any motivation to do so. Nor would a person of ordinary skill in the art have had a reasonable expectation of success in achieving the claimed invention (methods to improve optical clarity of single crystal CVD diamond) from Vagarali's methods to improve color of natural diamond. At the time of the invention, there were several known differences between natural and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for natural diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond. I thus disagree with Dr. Pinneo's claim that a person of skill in the art would have been motivated by "the similar composition and properties of CVD diamonds and natural diamonds," Pinneo R. at ¶1433 or his assertion that "a CVD diamond has comparable chemical, physical and optical properties as a Type IIa natural diamond," *id*. ¶ 1430. *See also* Pinneo R. at ¶¶1436, 1440, 1441, 1458. Dr. Pinneo is also incorrect to assert that it would have "obvious to try" "obvious to apply"

Vagarali to single-crystal CVD diamond, or that there was a motivation to do so or reasonable expectation of success in achieving the claimed methods. Pinneo R. at ¶¶1428, 1430-1432.

493. Furthermore, I disagree with Dr. Pinneo reliance (Pinneo R. at ¶1429) on Vagarali's exploration of methods to change the color of natural diamond for his assessment of the '189 patent, which pertains to improvements of optical clarity of single crystal CVD diamond. These differing goals, combined with the known structural and compositional differences between natural IIa and single crystal CVD diamond, would have prevented any motivation to combine or reasonable expectations of success.

b. Claim 1

494. Beyond the lack of motivation or reasonable expectation of success, Vagarali also fails to disclose the elements of claim 1. As explained above, Vagarali pertains to natural Type IIA diamond, not single crystal CVD diamond. There was also no motivation at the time of the invention to apply Vagarali to single crystal CVD diamond or a reasonable expectation of success in achieving claim 1's method of improving optical clarity of single crystal CVD diamond. Vagarali thus fails to render claim 1 obvious.

495. Vagarali also fails to anticipate claim 1 because it fails to disclose all its claim elements, and thus fails to disclose each element as arranged in claim 1.

496. I take up each claim element in turn and explain why a person of ordinary skill in the art would not have interpreted Vagarali to disclose the claim element or render it obvious.

(i) 1[pre]: "A method to improve the optical clarity of CVD diamond"

497. While I understand that the preamble of claim 1 is not given a limiting effect under the Court's claim construction order, I will briefly assess it to provide as complete an opinion as possible. This assessment, however, is not necessary to reach my conclusion that Vagarali fails to

anticipate claim 1 or render it obvious. As explained below, Vagarali fail to disclose claim elements 1[a] and [b] whether considered alone or in combination with skilled artisan knowledge, and there was no motivation to apply Vagarali to single-crystal CVD diamond, or reasonable expectation of success in achieving the claimed method.

498. Beyond that, it is also my view that Vagarali fails to disclose "a method to improve the optical clarity of CVD diamond." As explained above, Vagarali is not directed to CVD diamond. It pertains to natural diamond. See, e.g., Vagarali ¶ 21. Vagarali therefore cannot anticipate claim 1.

499. Moreover, as discussed above, Vagarali states that an advantage of the claimed methods was "the ability to retain optical clarity of treated diamonds disclosed herein." *Id*. ¶ 20. Dr. Pinneo quotes this language in his report. Pinneo R. at ¶1437. It is not clear that Vagarali's methods were intended to improve optical clarity.

500. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the natural diamond methods of Vagarali to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between natural and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for natural diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing

steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

501. Accordingly, there was no motivation to apply Vagarali, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

(ii) 1[a]: "where the CVD diamond is single crystal CVD diamond"

502. Vagarali fails to disclose this claim element and, even if combined with skilled artisan knowledge, does not render it obvious. As explained above, Vagarali pertains to natural diamond (see, e.g., Vagarali ¶ 21), not "single crystal CVD diamond." It fails to disclose "CVD diamond [that] is single crystal CVD diamond." Vagarali therefore cannot anticipate claim 1.

503. Even if considered in combination with skilled artisan knowledge, Vagarali still fails to disclose this claim element. There were several known differences between natural and CVD diamond, and persons of skill in the art did not consider them interchangeable. I thus disagree with Dr. Pinneo's claim that Vagarali would have been understood "to disclose a method relating to CVD diamond where the CVD diamond is single crystal CVD diamond." Pinneo R. at ¶1442.

504. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the natural diamond methods of Vagarali to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between natural and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure

techniques were more attractive for CVD diamond than for natural diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond. Dr. Pinneo is mistaken to say that "one skilled in the art would have had a reasonable expectation of success in using the Vagarali annealing technique with a single crystal CVD diamond to achieve the predictable result of strength enhancement." Pinneo R. at ¶1443.

505. Accordingly, there was no motivation to apply Vagarali, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

(iii) 1[b]: "by raising the CVD diamond to a set temperature of at least 1500° C and a pressure of at least 4.0 GPA outside of the diamond stable phase"

506. Vagarali fails to disclose this claim element and, even if combined skilled artisan knowledge, does not render it obvious. The claim requires these conditions for CVD diamond. As explained above, Vagarali pertains to natural diamond (see, e.g., Vagarali ¶ 21), not CVD diamond. It fails to disclose raising "the CVD diamond" to the claimed conditions. Vagarali therefore cannot anticipate claim 1.

507. Even if considered in combination skilled artisan knowledge, Vagarali fails to the disclose the claimed conditions. There were several known differences between natural and CVD diamond, and persons of skill in the art did not consider them interchangeable. I thus disagree with Dr. Pinneo's claim that Vagarali would have been understood "to disclose a method relating to CVD diamond which include raising CVD diamond" to the claimed conditions. Pinneo R. at ¶1453.

508. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the natural diamond methods of Vagarali to single crystal

CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between natural and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for natural diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

509. Accordingly, there was no motivation to apply Vagarali, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

c. Claim 2

510. Vagalari fails to disclose the additional element of claim 2. As explained above, Vagarali pertains to natural diamond, not single crystal CVD diamond. There was also no motivation at the time of the invention to apply Vagarali to single crystal CVD diamond or a reasonable expectation of success in achieving claim 2's method. Vagarali thus fails to render claim 2 obvious.

511. Vagarali also fails to anticipate claim 2 because it fails it fails to disclose all the elements of claim 1, from which claim 2 depends, and thus fails to disclose each element as arranged in claim 1. It also fails to disclose the additional element of claim 2, as explained below, and thus fails to disclose each element of claim 2 as arranged in the claim.

(i) 2: "The method of claim 1 wherein the CVD diamond is a single crystal coating upon another material."

512. Vagarali fails to disclose this claim element and, even if combined with skilled artisan knowledge, does not render it obvious. As explained above, Vagarali pertains to natural diamond (see, e.g., Vagarali ¶ 21), not CVD diamond. It fails to disclose "CVD diamond [that] is a single crystal coating upon another material." I thus disagree with Dr. Pinneo's claim that Vagarali would be understood to "disclose that 'the CVD diamond is a single crystal coating upon another material.'" Pinneo R. at ¶1457. Vagarali therefore cannot anticipate claim 2.

513. Furthermore, as explained above, there were several reasons why persons of skill in the art were not motivated to apply the natural diamond methods of Vagarali to single crystal CVD diamond. Nor would such persons have had a reasonable expectation of success in doing so, even though both materials are diamond and were known to have certain similarities. At the time of the invention, there were several known differences between natural and single crystal CVD diamond. The cause of discoloration for each was unknown, they were believed to differ, there were known compositional differences between them (e.g., incorporated hydrogen content, graphitic defects), there were known structural differences between them, and low-pressure techniques were more attractive for CVD diamond than for natural diamond. The high cost of high-pressure equipment and known problems with breaks and cracks occurring during pressurizing steps also discouraged high-pressure treatments for CVD diamond, and the disincentives were exacerbated by the known structural characteristics of CVD diamond.

514. Accordingly, there was no motivation to apply Vagarali, whether alone or in combination with skilled artisan knowledge, to render this element obvious, nor a reasonable expectation of success in so doing.

person of ordinary skill in the art could practice the invention without undue experimentation. My understanding is that whether the patent is enabled is a separate inquiry from written description, which I have already addressed above. Regardless, for the same reasons I disagree with Dr. Pinneo's written description opinion, I disagree with his opinion that the patent is not enabled, which largely simply incorporates by reference his prior written description opinions. *See* Pinneo R. at ¶¶1173-1222.

751. At the onset, Dr. Pinneo's opinion that the patent is not enabled largely turns on statements made in a November 2018 financial presentation by Huron Capital ("Huron Capital Presentation"). *See* Pinneo R. at ¶1173. More specifically, the Huron Capital Presentation compared the '078 Patent with vague details of certain trade secrets related to the WD's commercial process. *See id*. (citing WD Lab Grown Diamonds & Huron Capital, Lender Presentation (Second Draft – Nov. 2018) (CARN-FEN_115436–463) at 7-8 (115442–543); WD Lab Grown Diamonds & Huron Capital, 271 Lender Presentation (Final Draft – Nov. 2018) (HUR_001440-68) at 7-8). According to Dr. Pinneo, the Huron Capital Presentation was drafted by attorneys from the law firm Perkins Coie. *See id*. n.40. My understanding is that whether a patent is enabled, however, is ascertained from the perspective of a person of ordinary skill in the art based on the patent specification. I accordingly do not find this Huron Capital Presentation meaningful as it relates to understanding of the '078 Patent—the opinions stated therein do not evidence how a skilled artisan would understand the disclosures of the '078 Patent. In any event, I note that the Huron Capital Presentation on its face is attributed to Huron Capital, an investment advisor according to the presentation. *See* WD Lab Grown Diamonds & Huron Capital, Lender Presentation (Second Draft – Nov. 2018) (CARN-FEN_115436–463) at 7-8 (115442–543); WD

Lab Grown Diamonds & Huron Capital, 271 Lender Presentation (Final Draft – Nov. 2018) (HUR_001440-68) at 7-8.

752. From the Huron Capital Presentation (seemingly drafted by persons who are not skilled in the art at issue here), Dr. Pinneo broadly posits that the '078 Patent is not enabled with respect to "(1) process control, (2) equipment design, and (3) specific recipes and parameters needed to grow single crystal diamond by microwave plasma chemical vapor deposition under the claimed conditions." Pinneo R. at ¶1173. I disagree with Dr. Pinneo's opinion and his characterization of this document, which does not speak to the enablement of the patent.

753. In fact, the Huron Capitol Presentation distinguishes the technology held by WD as trade secrets from the invention claimed in the '078 Patent. *See* WD Lab Grown Diamonds & Huron Capital, 271 Lender Presentation (Final Draft – Nov. 2018) (HUR_001440-68) at 6. It characterizes these trade secrets as aspects of the manufacturing process that relate to "commercially viable production" and to make the process "commercially feasible." *See id*. at 6-7. According to the presentation, these manufacturing processes are distinct from, and not disclosed in, the patent. *See id*. It is my understanding that a patent specification is not required to enable commercialization in order to satisfy the enablement requirement. What's more, it is my understanding that a patentee may later develop processes (including those kept as trade secrets) related to commercial scale up of, or product or process improvements to, the invention. Such later developments do not support whether an enabling disclosure was provided such that a person of ordinary skill in the art could practice the invention without undue experimentation based on the patent's disclosures.

754. To illustrate, the Huron Capital Presentation explains that the '078 Patent discloses the parameters under which single-crystal diamonds can be manufactured under a range of

parameters. *See* WD Lab Grown Diamonds & Huron Capital, 271 Lender Presentation (Final Draft – Nov. 2018) (HUR_001440-68) at 6-7. In layperson's terms, according to the presentation, the patent discloses how to make a cake; the trade secrets provide additional flourishes to the cake's recipe (e.g., chocolate chips) alongside more specific information regarding the oven, baking time, and baking temperature. *See id*. at 8. That additional improvements can be made on a recipe does not support that a person of skill in the art was unable to follow the initial recipe without undue experimentation. And it is my opinion that, like a baker with a cake recipe, a skilled artisan here can practice the invention claimed in the '078 Patent without undue experimentation absent the later refinement and commercialization of the process. Indeed, Dr. Pinneo's cursory opinion fails to show otherwise. *See* Pinneo R. at ¶1173.

755. Dr. Pinneo next opines that, it is his opinion, the '078 Patent "did not enable a POSA to make and use the claimed subject matter without undue experimentation for the reasons set out in Section XI, Written Description," which he incorporates by reference. *Id*. at ¶1174. I have addressed Dr. Pinneo's written description opinions above and incorporate that response by reference. Notably, Dr. Pinneo's opinions with respect to written description do not address the amount of experimentation that would be required to practice the invention (i.e., whether "undue experimentation" is required) for any limitation of the claim. My understanding therefore is that they accordingly do not establish lack of enablement.

756. Dr. Pinneo's opinion that "the '078 Patent does not enable a POSA who measured thermal gradients less than 20ºC and grew a diamond with no observable polycrystalline material to determine which embodiments are operable and which embodiments are inoperable with any amount of experimentation," *id*. at ¶1175, is wholly unsupported. In any event, for the reasons stated above, I disagree. Moreover, Dr. Pinneo does not answer the relevant inquiry, e.g., the

without undue experimentation. *Id*. at ¶1179. Indeed, as described above, it was well within a POSA's skills and the patent's disclosures to utilize these temperatures such that undue experimentation was not necessary. Nevertheless, Dr. Pinneo again fails to address the amount of experimentation required. *See id*.

763. Finally, Dr. Pinneo again claims that the '078 Patent does not enable growth of "large, high-quality single-crystal diamond (i.e., a colorless diamond with insubstantial polycrystalline material)" without undue experimentation. *Id*. at ¶1180. Again, this is a bald assertion with no discussion of the amount of experimentation required. For the reasons above, I disagree. My understanding is that the burden rests with the accused infringer to prove that the patent's disclosure is insufficient to enable one of ordinary skill in the art to practice the invention absent undue experimentation. Dr. Pinneo has offered no evidence in support of lack of enablement for all of the above theories.

a. The *Wands* Factors

764. Dr. Pinneo next purports to apply the *Wands* factors "to assess enablement." *Id*. at ¶¶1181-1222. It is unclear to which of his many theories above he intends apply these considerations. Regardless, I address his opinions *Wands* factors below.

(i) Dr. Pinneo's Opinions with Respect to "Factors (1 and 2): quantity of experimentation necessary and the amount of direction or guidance presented:"

765. Dr. Pinneo's opinion regarding *Wands* Factors 1 and 2 is focused on the amount of time needed to grow a diamond that would be commercially preferable—i.e., large and colorless. *See id*. at ¶1205; *id*. at ¶¶1181-1205. That is, Dr. Pinneo claims that, e.g., the gas mixtures in the patent would result in "a yellow diamond, unsuitable for commercial sale," *id*. at ¶1185, while other processes may result in a "brown" diamond." *Id*. at ¶1186; *see also id*. at ¶¶1185-86, 1188-

95. Dr. Pinneo likewise opens that patent doesn't disclose the precise run time needed to make such commercially viable diamond such as those it sells. *Id*. at ¶¶1182-83. Furthermore, according to Dr. Pinneo, the complete range of temperatures disclosed in the patent might yield "unsuitable colors" or "non-monocrystalline." *Id*. at ¶1187. Notably, these opinions are wholly unrelated to the various enablement theories disclosed above. Dr. Pinneo likewise ignores that, e.g., the color of the resultant diamonds are not claimed in the '078 Patent.

766. Regardless, to the extent that Dr. Pinneo is opining that the patents are not enabled because undue experimentation would be required to make a commercial product, a patentee is not required to enable commercial production. Again, the patent does not claim a specific color or commercial suitability of the diamond. The patentee need only enable one of skill in the art to practice the invention without undue experimentation. Here, that disclosure has been made. That WD may have continued its work—improved upon its process to make more commercially appealing diamonds—is not the relevant legal inquiry. And Dr. Pinneo does not offer evidence that the invention could not be practiced without undue experimentation based on the specification; instead, his opinion turns on the notion that the invention could be improved—the quality of the diamonds could be improved—with additional disclosures.

767. For these reasons, commercial manufacturing procedures of other companies (e.g., Nouveau), their timeline for commercial growth, and their available equipment (Pinneo R. at ¶¶1182-84) are irrelevant. To the extent that Nouveau's manufacturing procedures are burdensome or limiting, or that their equipment is limited, it would reflect commonplace commercial limitations, i.e., barriers to market entry, not barriers to practicing the '078 Patent based on its disclosure.

768. Dr. Pinneo further focuses on a Carnegie's statements regarding color issues that may arise in diamond production (*id*. ¶¶1185-86, 1192-94), but the claims have no color requirement. Any subsequent optimization by Carnegie and M7D, or technology they later developed to improve quality, is irrelevant to whether one of skill the art could practice the invention as claimed. *Id*. ¶¶1188-89, 1196-97, 1202-05. Dr. Pinneo presents calculation of certain "chances of success" to manufacture diamonds of a certain quality that are wholly speculative and irrelevant. *Id*. ¶¶1198-1201. The patent specification enables the growth of single crystal CVD diamond, and any difficulties in achieving a particular quality level beyond the claims do not support that one of skill in the art could not practice the invention without undue experimentation.

(ii) Factor (3): the presence of absence of working examples

769. Shifting his focus from the color of the diamond to the ability to assess temperature gradients and the shape of the holder, Dr. Pinneo changes his theory of non-enablement with respect to Factor 3, the presence or absence of working examples. *See* Pinneo R. at ¶¶1206-22. Regardless, for the reasons below, I disagree with his opinions.

770. First, Dr. Pinneo again retreats to the Huron Capital Presentation, claiming that it "correctly noticed" that the '078 Patent "fails to provide a POSA with practical guidance on a range of parameters required to successfully operate a commercial diamond reactor: (i) which gases combinations are effective; (ii) how the gases should be mixed; (iii) how the reactor should be preheated, cleaned, and cooled; (iv) how the diamond should be smoothed when growing is suspended; (v) what kind of microwave power should be applied; and (vi) how the microwave power should be controlled." *Id*. at ¶1206. The patent does not claim operating "a commercial diamond reactor." To the extent that those associates with the patentees may later have developed additional knowledge regarding how best to operate such a reactor—for example, how to ensure a

consistent reactor temperature—does not support whether the patent itself contains adequate information to practice the invention, which Dr. Pinneo does not address. For the reasons I explain throughout my report, a person skilled in the art could practice the actual invention claimed without undue experimentation.

771. Second, and again based on the Huron Capital presentation, Dr. Pinneo states "the '078 Patent fails to disclose equipment capable of determining 'whether the temperature stays consistent,'" which Dr. Pinneo claims is "critical" to practicing the invention. *Id*. at ¶1207-08. Aside from referencing his prior opinions regarding written description, Dr. Pinneo provides no additional support for this theory. *See id*. at ¶¶1207-12. For the reasons I have already addressed in detail above, I disagree with these opinions. One of ordinary skill in the art would be capable of assessing the thermal gradient across the growth surface.

772. Third, Dr. Pinneo claims that, the '078 Patent does not provide "working examples of the equipment necessary to grow single-crystal-diamond on a side-contact-holder." Pinneo R. at ¶1213. That is, "for the reasons discussed in Section XI (Written Description)," Dr, Pinneo "do[es] not believe it would be possible to grow single-crystal-diamond on in a standard open-holder reactor." *Id*. As I describe above, I disagree. A person of ordinary skill, equipped with the patent and the knowledge of the prior art, could have used an open-holder in the claimed process without undue experimentation, as discussed above.

(iii) Dr. Pinneo's Opinions with Respect to "Factors (4 and 7): nature of the invention and the predictability or unpredictability of the art

773. With regard to Factors 4 and 7, Dr. Pinneo claims that, due to their plasma, "a diamond reactor is too complicated to accurately or reliably model," thus presumably supporting some unknown lack of enablement theory. Pinneo R. at ¶¶1214-15.

774. I do not disagree that there is inherent variability in this art, though I disagree that invariability would result in undue experimentation. Indeed, this variability is precisely why the specification provides a list of variables with instruction for adjustment of those variables, as discussed throughout this report. Importantly, the invention here is not a "one size fits all" solution that can be achieved through the robotic following of commands and examples. The identified variables must be adjusted with regard to each diamond or batch, or any variations between equipment or design decisions, as envisioned in the patent. Accounting for these variables as disclosed in the specification is routine to a person or ordinary skill when in possession of the specification.

(iv) Dr. Pinneo's Opinions with Respect to "Factors (5)"

775. While Dr. Pinneo otherwise claims that the state of the art was so detailed that the invention was either anticipated or rendered obvious, with respect to enablement, he reduces the state of the art to a single doctoral dissertation. *See* Pinneo R. at ¶¶1216. This is at odds with his opinions regarding the many prior art references detailed in his report. Regardless, I have discussed aspects of the prior art relevant to a person of ordinary skill's understanding of the patent above.

776. I disagree with Dr. Pinneo's opinion that the state of the art is limited to "the ability to grow near-colorless single-crystal diamonds while maintaining sub-20°C thermal gradients during batch production on a typical open-holder reactor." *Id*. at ¶1217. Dr. Pinneo has unreasonably cabined the invention and ignores the knowledge of a person skilled in this art, which I have already addressed where relevant above.

777. Finally, Dr. Pinneo claims that if the invention is limited to "the ability to maintain sub-20°C thermal gradients (from a macroscopic perspective) during production of a thin and

poorly colored diamond in a low-power research reactor, then the prior art was closer to the invention ….” *Id*. at ¶1218. The art should not be so narrowly defined. Regardless, the claims are not limited to particular thickness, color, or types of reactors. Importantly, Dr. Pinneo concedes that the prior art provided a person of skill in the art with certain disclosures relevant to production of diamonds per the claimed method. This supports enablement.

(v) Dr. Pinneo’s Opinions with Respect to “Factors (6) Relative Skill in the Art”

778. Dr. Pinneo concedes that the relative skill in the art is high. *Id*. at ¶1219. In fact, a person of ordinary skill in the art would be highly trained such that issues such as holder shape and temperature measurement would be well within their skill.

(vi) Dr. Pinneo’s Opinions with Respect to “Factors (8) breadth of claims”

779. With regard to the breadth of the claims, Dr. Pinneo opines that the “asserted claims broadly attempt to monopolize all mechanisms for preventing a natural phenomenon (e.g., the edge effect).” *Id*. ¶1220. As I address elsewhere in the report, I disagree that the claims are directed to a natural phenomenon.

780. Dr. Pinneo next refers to characterizations of patent in the Huron Capital Presentation and in MD7 customer materials. *Id*. at ¶¶1221-22. I do not agree that the claims are “extremely broad,” as quoted from these sources. Here, the patent claims a specific and novel method for diamond production with specific steps. Regardless, I would prefer to focus my analysis on the patent itself over the opinions of those unskilled in the art or customer materials.

781. My understanding is that it is the accused infringer’s burden to establish that a patent does not contain an enabling disclosure, and that there is a presumption that a patent is enabled. Dr. Pinneo fails to meet this burden. His opinions, which ignore vast swaths of the patent specification and disregard the high skill of a person of ordinary skill in the art, fail to establish

that the specification does not enable a person of ordinary skill in the art to practice the invention without undue experimentation.

C. The Asserted Claims of the '078 Patent are not Indefinite.

1. Legal Standards Regarding Indefiniteness

782. My understanding is that a patent is invalid for indefiniteness if its claims, read in light of the specification and the prosecution history fail to inform with reasonable certainty those skilled in the art about the scope of the invention. In other words, a patent must be precise enough to afford notice of what is claimed. While some uncertainty is the acceptable, a patent must be precise enough to give clear notice of what is claimed to the public, to apprise them of what is still open to them. Similarly, claims are not indefinite merely because some experimentation is needed to determine if claim limitations are met.

783. My understanding is that numerical precision in a claim is not required, if the claims reasonably apprise one skilled in the art, in light of the specification and prosecution history, about the scope of the invention with reasonable certainty. Similarly, claims are not indefinite merely because some experimentation is needed to determine if claim limitations are met, so long as the experimentation is not undue.

784. My understanding is that definiteness is a question of law for a court to determine, but that it sometimes involves underlying factual determinations. In assessing definiteness, claims are to be read in light of the patent's specification and prosecution history, and courts apply the viewpoint of a person skilled in the art at the time the patent was filed.

785. My understanding is that it is presumed that the '078 Patent is valid, and that Defendants bear the burden to prove by clear and convincing evidence that the '078 Patent is indefinite.

substrate, you can get a temperature gradient."); *see also id*. at 128:17-129:4 ("A. So you can focus on different parts of a diamond crystal. If you have a large substrate and you have, you know, like a 2-millimeter focusing area, you can manually scan the surface and get an idea of the temperature gradient. Q. So you have to physically move where the pyrometer is pointing? A. Yeah. You can just move it and focus on different areas. Q. Is that something you did as part of your process? A. Yeah. We used to measure the temperature gradient all the time.").

789. Accordingly, for the reasons above, I disagree with Dr. Pinneo's opinion the claims are indefinite. One of ordinary skill in the art would have the ability to determine whether he or she is practicing the claims if the POSA measured thermal gradients under 20° C.

XII. NON-PRIOR ART VALIDITY OF THE RE'189 PATENT

A. Enablement and Written Description

790. I understand that, to meet the enablement requirement, a patent must contain a written description of the invention, in such a way that one skilled in the art, at the time of the patent application, is enabled to make and use the invention, without undue experimentation. To determine if undue experimentation, the following factors are weighed, which are commonly referred to as the "*Wands* Factors": (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims. These factors are exemplary, not mandatory, and while experimentation must not be "undue," some amount of routine experimentation does not mean that a patent is not enabled.

791. To meet the written description, a patent specification must convey to a person of skill in the art at the time the patent application was filed that the inventor had possession of the

claimed subject matter. This requires an objective inquiry, limited to the four corners of the patent specification, from the perspective of a person of ordinary skill in the art.

792. I further understand that open-ended claims, or claims to ranges that are bound at only one end, do not fail to meet the enablement and written description requirement as long as there is an inherent upper limit, even if not precisely known, and the specification enables one of skill in the art to approach that limit, to practice the invention, and to understand that the inventors had possession of the claimed invention.

793. Dr. Pinneo argues that "the asserted claims of the '189 patent are not enabled because undue experimentation would be required to determine the boundary between the diamond stable phase and the graphite stable phase as is required by the phrase 'raising the CVD diamond to a set temperature of at least 1500° C. and a pressure of at least 4.0 GPA outside of the diamond stable phase' in claim 1." Pinneo R. at ¶1480. He notes that the specification does not disclose a particular phase diagram nor teaches one skilled in the art how to determine the boundary over the claimed range. I disagree that the claims fail to satisfy the enablement requirement.

794. As a threshold matter, a person of skill in the art would not need to derive the entire phase boundary to practice the claimed invention. A person of skill in the art, moreover, would be very capable of determining the phase boundary from resources available at the time and readily used by chemists—namely, as Dr. Pinneo notes (*id*. at ¶1464), the carbon phase diagram had been published by several researchers, including Bundy in 1995. A skilled artisan would survey the available literature and make a well-informed determination of the phase boundary and would determine within the uncertainty permitted in the field whether a particular condition was inside or outside the diamond-stable phase. Any uncertainty associated with the phase diagram would not prevent a skilled artisan from practicing the claims.

795. Accordingly, because a skilled artisan would only need to review known reference material, undue experimentation would not be required. The Wands factors confirm this: (1) the quantity of experimentation necessary would be minimal, (2) the claim language presents the needed guidance, (3) a working example is provided in the specification, (4) the nature of the invention would not prevent a skilled artisan from practicing the patent, (5) the art provided sufficient resources to ascertain the phase diagram within the uncertainty accepted in the field, (6) those in the art have considerable skill, (7) any unpredictability would not prevent a person of skill in the art from practicing the patent, and (8) the breadth of the claims also would not prevent a person of skill in the art from practicing the patent.

796. While no express upper limit is given for the claimed temperature and pressure ranges, a person of skill in the art would understand that the upper limit was sufficiently defined, even if not precisely known. A person of skill in the art would be familiar with annealing condition and know, for example, that researcher had annealed diamond at temperatures and pressures as high as 2025^{o}C and 6 GPA. Those conditions were reported by Kanda in 1980 and Webb reported diamond annealing at up to 1700^{o} C and 60 kbar in 1995. Skilled artisans would understand that the claimed temperature and pressure ranges were bound by the conditions attainable with state-of-the-art equipment. Accordingly, I disagree with Dr. Pinneo that a skilled artisan would need "an estimate of the boundary between the diamond stable phase and the liquid stable phase of carbon or an identification of a technique for determining what is "outside the diamond stable phase and in the liquid stable phase. Pinneo R. at ¶1483; *see also id*. at ¶¶1484-1485. A skilled artisan would not seek to anneal diamond at conditions leading to liquid carbon, nor would a skilled artisan understand the claims to cover conditions in those ranges. The conditions in which carbon is liquid are not regularly replicated in scientific labs or in facilities manufacturing CVD diamond. In fact,

annealing presses for extreme conditions are made from refractory material that remains solid at high temperatures, and tantalum carbide (TaC), for example, has one of the highest known melting points of 3877±150°C. Chiotti at 124, Table 1.

797. The unbound nature of the ranges would also not prevent a person of skill in the art from understanding that the inventors were in possession of the invention. A person of skill in the art would understand that the inventors had possession of claimed annealing methods within the rages attainable in the field and would not expect or understand that the inventors claimed unattainable annealing conditions in the carbon liquid phase.

B. Definiteness

798. As explained above, I understand that a court may find a claim term indefinite only where the claim term, read in light of the specification and the prosecution history, fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. I further understand that a patent carries the presumption of validity—and therefore definiteness—and that claim terms can only be found to be indefinite by a clear and convincing standard.

799. Dr. Pinneo asserts that "the Asserted Claims of the '189 patent are indefinite" because "the "intrinsic record offers no objective boundaries for ascertaining whether a given temperature-pressure condition is one that is 'together outside of the diamond stable phase' or is one that is not." Pinneo R. at ¶ 1461. He believes the claims are indefinite because "the boundary between the diamond stable phase and the graphite stable phase cannot be reasonably ascertained for the range of temperature and pressures" given in the claims, and a skilled artisan "could only estimate the boundary line between the diamond stable phase and the graphite stable phase. *Id*. at ¶¶1462-63; see also *id*. at ¶¶1475-76. I disagree.

800. As an initial matter, I understand that patent claims are not indefinite if the claim language is as precise as the subject matter permits. A person of ordinary skill in the art, at the

CARN-FEN_00208461-208483 / CARN-PGD_00237069-237091. These successful licensing efforts provide evidence that the inventions of the asserted patents are non-obvious.

E. Teaching Away

838. I also understand that, if the state of the art teaches away from the claimed invention, this indicates non-obviousness. Around the time of the patents, there was teaching away or discouraging of MPCVD diamond synthesis due to its prohibitive costs. For example, the power expense associated with MPCVD made its use commercially unviable. For example, *May* noted in 2000 that "[r]esearchers and industry are currently concentrating upon developing methods to scale up the CVD processes and reduce production costs to the point at which it becomes economically viable to use diamond as the material." May at 492. As a result, the scientific community explored alternatives such as HFCVD. For example, a patent to Sun issued in 2000 stated: "A major advantage of HFCVD of diamond films, relative to other methods of diamond film growth such as microwave plasma CVD (MWCVD), radiofrequency CVD, and plasma jet CVD, is the low equipment investment costs, and the ease in scaling up the production to a large area substrate." *Sun* 1:40-48.

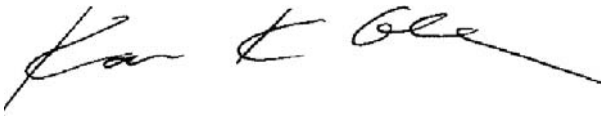
839. As for the annealing methods claimed in the '078 patent, there was also teaching away due to prohibitive costs. The equipment needed to achieve high-pressure conditions was large and expensive, and alternative low-pressure processes were explored by several researchers including Carnegie. *See Sumiya* 12: 53-67; *Liang 2009*. The art therefore taught away from the high-pressure methods for CVD diamond disclosed in the '189 patent.

XV. CONCLUDING REMARKS

840. I understand that any additional rulings regarding claim construction, any change in position on claim construction by the parties, including an apparent change by Defendant in claim construction by application of the prior art to the claims or application claims to accused

products, or on receipt of any additional relevant information, may require me to amend or supplement my opinions. I will do so in a timely manner should a response to that additional information, changed position on claim construction, or ruling relevant to claim construction be warranted.

Dated: October 9, 2020



Karen K. Gleason, Ph.D.

CERTIFICATE OF SERVICE

I hereby certify that on October 9, 2020, I caused to be served copies of the foregoing **Expert Report of Karen K. Gleason, Ph.D. Regarding Validity of U.S. Patent No. 6,858,078 and RE41,189** on the following counsel via email:

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